DOCUMENT RESUME

ED 129 607 SE 021 409

AUTHOR Gilmartin, Kevin J.; And Others
TITLE Development of Scientific Careers: The High School Years. Final Report.
INSTITUTION American Institutes for Research in the Behavioral Sciences, Palo Alto, Calif.
SPONS AGENCY National Science Foundation, Washington, D.C.
PUB DATE Aug 76
GRANT NSF-EPP-74-11549
NOTE 216p.; Contains numerous small print in Tables and Appendices

EDRS PRICE MF-$0.83 HC-$11.37 Plus Postage.
DESCRIPTORS *Career Choice; *Careers; *Educational Research; Research; *Science Careers; Science Education; *Secondary Education

ABSTRACT

This document investigates the processes which influence a high school student's move toward or away from a career in science. Utilizing a Scientific Potential Index, 1,200 scientists and 22,500 non-scientists who were in high school in 1960, and 1,142 current high school students were interviewed concerning career plans and related matters. Findings included: (1) career plans are strongly related to parents' level of education; (2) the largest determinant of successful achievement of career plans in science is math ability; (3) the number of females planning science careers has tripled since 1960; (4) underrepresentation of women in science is mediated by factors not related to ability; (5) the measured mean Scientific Potential and the science career plans among blacks and Spanish surname students are far lower than those of whites and Orientals; and (6) socioeconomic family status related positively to Scientific Potential but appeared to be entirely mediated through abilities that had developed by the eleventh grade. (SL)

AIR-48200-8/76-FR

DEVELOPMENT OF SCIENTIFIC CAREERS: THE HIGH SCHOOL YEARS

FINAL REPORT

Kevin J. Gilmartin
Donald H. McLaughlin
Lauress L. Wise
Robert J. Rossi

August 1976

AMERICAN INSTITUTES FOR RESEARCH
Post Office Box 1113 / Palo Alto, California 94302

DEVELOPMENT OF SCIENTIFIC CAREERS:
THE HIGH SCHOOL YEARS

Final Report

Kevin J. Gilmartin
Donald H. McLaughlin
Lauress L. Wise
Robert J. Rossi

American Institutes for Research
Palo Alto, California

August 1976

This research was conducted under Grant Number EPP74-11549 from the National Science Foundation to the American Institutes for Research. The conclusions are those of the authors and do not necessarily reflect the views of the National Science Foundation.

BRIEF

This document grew out of the concern of the National Science Foundation to increase the understanding of the processes by which today's high school students move toward or away from careers in science. Specifically, they were concerned about whether the lack of women and ethnic minorities in science might be related to a lack of some types of career guidance information in high school. In accord with their concern, the National Science Foundation awarded a research grant to the American Institutes for Research in July 1974 to study "the career guidance factors that affect the development of high school students' scientific potential." The work carried out in that study constitutes the substance of this final report.

In the course of the project, the development of the careers of 1,200 scientists who were in high school in 1960 and who have contributed their responses to the Project TALENT longitudinal survey over the intervening period were examined. Also essential for the study were the responses of 22,500 other Project TALENT participants not pursuing science careers.

The rationale for this report is that there are career guidance factors that may be subject to intervention at the high school level, resulting in more successful development of careers in science. These factors were empirically explored, using the responses of Project TALENT participants and of a sample of 1,142 of today's high school students who were questioned concerning their career plans and related matters. The results reveal not only some changes that have taken place during the last 15 years but, more importantly, the factors indicative of barriers to the scientific development of women and of members of minority groups that continue to operate. This report is limited to the high school years. Further study will be needed of the preceding and subsequent phases of science career development.

The report is organized in five chapters, with details appended. The first chapter outlines the design and methods of the study. The second chapter develops the rationale for the approach used in the project. The empirical results are presented in detail in chapters three and four, concerning, respectively, the measurement and prediction of scientific potential among high school students, and the nonability indicators that a science career will be realized from that scientific potential. In the final chapter, the authors draw their conclusions concerning the implications of the study, both in terms of the career development of potential scientists and in terms of further research that needs to be done.

Findings

- More than 3 times as many female high school students were planning careers in science in 1975 as in 1960. Of the 1960 11th grade Project TALENT participants, 32% of the males and 5% of the females had had science career plans in high school. In contrast, 24% of the males and 17% of the females had science career plans in the 1975 sample.

- Although the 1975 sample exhibited less sex effect on science career plans, large differences were still evident between various ethnic groups: 14% of the blacks, 15% of the Spanish surname students, 23% of the whites, and 29% of the Orientals had science career plans.

- Although students displayed some knowledge of their own abilities, interests, and values, of the characteristics of people in various occupations, and of the educational requirements and salaries in various occupations, there were several distinct knowledge deficiencies that may inhibit establishment of careers in science. Very few differences were evident between the sexes in self-perception and perceptions of careers; the underrepresented minorities, however, were significantly less accurate than others in their estimates of their relative abilities, interests, and values and in their estimates concerning people in selected occupations.

- Parents' level of education displayed a strong relation to their offspring's career plans in high school. If either parent had attended college, the student was much more likely to have a science career plan; this relation was as strong for parents who had <u>not</u> completed college as for parents who had graduated.

- Only 12% of the males and 6% of the females who were planning a science career while in 11th grade actually persisted in their plans over the next twelve years. A quarter of the men and over half of the women in science in 1972 had had <u>nonscience</u> career plans in high school in 1960.

- The Scientific Potential index, composed of high school abilities that best discriminate between having a scientific vs. nonscientific job 11 years after high school, fared well in validation analyses. Not only did the ranking of 50 science occupations and 150 nonscience occupations by mean Scientific Potential display a high level of face validity, but also Scientific Potential was found to be predictive of eminence *within* a sample of science occupations as measured by quality of undergraduate and graduate schools, number of citations in the Science Citation Index and the Social Science Citation Index, and being listed in American Men and Women in Science.

- There were only minimal differences in mean Scientific Potential between males and females: females averaged less than one-half standard deviation below males in 1960 and approximately one-quarter standard deviation below males in 1975. Thus, the underrepresentation of women in science careers is largely mediated by factors not related to the development of abilities before and during high school. On the other hand, large differences were found among the four major ethnic groups in the 1975 sample, with blacks and Spanish surname students scoring one standard deviation below whites and Orientals. Thus, the factors that lead to underrepresentation of minorities in science are largely mediated by differences in levels of abilities developed before and during high school.

- Various aspects and dimensions of social advantage were positively related to Scientific Potential. However, partial correlations between SES and a science career, controlling for Scientific Potential, were very low. The effects, in terms of entering or not entering a science career, of the socioeconomic status of one's family appear to be mediated almost entirely through abilities that have developed by 11th grade; given equal abilities, SES has little relation after high school to achieving a science career.

- The nonscience occupations, other than homemaking, that contained the largest numbers of women with high Scientific Potential were the various teaching specialties and registered nurses. Black men with high Scientific Potential tended to be employed in business management.

- Of the students with Scientific Potential scores in the upper third of the 1975 sample, 94% of the females and 97% of the males were planning to attend a 4-year college.
- High school students with high Scientific Potential scores who would not consider working in any science occupation were more likely to be white, to have well-educated parents, and to report lower grades in most or all of their courses than a comparison group of high science ability students who had not rejected all science careers. The number of these students was not as large as one might have expected; seven out of every eight students with high Scientific Potential scores had not rejected the idea of a science career for themselves, although only about 40% were specifically planning one.

7

ACKNOWLEDGMENTS

During the course of this project, Donald McLaughlin served as project director, Robert Rossi was the researcher responsible for the collection of data on high school students in 1975, Kevin Gilmartin carried out and reported the largest portion of the data analyses, and Lauress Wise contributed to key aspects of the data analysis as well as developing a computer system to draw ability and interest profiles for the high school students participating in the study.

The authors wish to thank those individuals who have made this report possible. Mykol Hamilton, George Posey, and Kathleen Williams collected major portions of the data; David Bain, Wendy Bartlett, and David Gross contributed to the data processing; and Emily Campbell and Sibyl Anderson provided administrative and typing/editing support. Collection of the data on the 1975 sample was made possible by the gracious cooperation of the school personnel: Paul Bellamy, William Gramacy, Frank Jacobsen, Benjamin Klotz, Norman Mathers, C. Moomau, Robert Myers, Carole Peek, Hilario Pena, Eileen Rice, Donald Richardson, Tom Ryan, Robert Sampieri, Josephine Spearman, Carmen Tarrazes, and Robert Tomasini. Our special thanks to Fred Strodtbeck for his help with the development of the Career Planning Survey. We appreciate the careful attention to details, the helpful suggestions, and the constructive criticisms of Marion Shaycoft and William Clemans of AIR and Philip Rever of the American College Testing Program (ACT) when reviewing earlier drafts of this report. The support of the National Science Foundation, and particularly of Dr. Richard West in the Science Education Directorate, has been most helpful. The administrative support within the American Institutes for Research, and especially of Dr. William Clemans, Director of the Career Development Research Program in AIR's Palo Alto office, has continually enhanced our opportunity to make a significant contribution through this report. Finally, the list of those who made the Project TALENT study possible is long and has been recounted elsewhere, but our special gratitude is felt for its designer and principal investigator, John C. Flanagan.

TABLE OF CONTENTS

Page

LIST OF TABLES

Page

LIST OF FIGURES

CHAPTER 1

Design of the Empirical Study

1.1 General Problem and Approaches

The problem--Establishing objectives for career guidance in science. This report is designed as a contribution to answering the question: What actions are most likely to help high school students pursue careers that are appropriate for their levels of science ability? More specifically, this project has been guided by the concerns expressed by the research staff of the Office of Experimental Projects and Programs in the National Science Foundation, namely:

1. What do students need to know as they consider educational and career options in science and technology?
2. What do students want to know as they consider educational and career options in science and technology?
3. How close is the fit between 1 and 2?
4. Are there special considerations to be reckoned with in the cases of women and members of ethnic minority groups?

Two distinct approaches have been undertaken by the authors to contribute some new empirical results to the consideration of this question. The first approach is to determine what types of relevant knowledge high school students lack, so that steps can be taken to provide that knowledge; and the second approach is to analyze the characteristics of high school students who later pursued scientific careers successfully, in order to provide today's students with information they need for making intelligent career plans with respect to science.

The first approach led to the administration of a questionnaire to 1,142 high school students from 11 high schools in eight different communities in California during the spring of 1975. The questionnaire assessed students' career plans, especially with respect to science careers, their levels of career-related knowledge, and the factors they perceived as influencing their career planning. The second approach led to analyses of the responses of some 23,000 Project TALENT participants, including over 1,200 currently in science careers, who took two days of tests and inventories while in the 11th grade in 1960 and who responded to follow-up questionnaires in 1972 when most of them were approximately 29 years old. In both cases, the data bases were designed to be sufficiently representative to enable conclusions to be reached that are relevant to today's students.

The study also addressed the problem of overcoming the barriers that keep particular groups of high school students from pursuing science careers successfully, especially members of racial and ethnic minorities in this country and women. Accordingly, in designing the recent assessment of high school students' initial science career development, care was taken to include sufficient numbers of appropriate groups in the sample. However, for the second approach based on Project TALENT, the data are often insufficient for separate analyses of the various groups because of the very small numbers of female and minority students who became scientists. While some results of the Project TALENT analyses are presented for both sexes, few are presented for separate racial/ethnic groups, and for some crucial analyses the white males constitute the data base. Most of the race and sex comparisons, therefore, will be based on the 1975 data.

1.2 Specific Research Objectives

In order to investigate scientific career development, a series of seven objectives were set out.

Objective 1: Development of a Scientific Potential index based on differences in high school ability between scientists and others, and observation of the correlates of Scientific Potential. The achievement of this objective allows the isolation of career development factors after controlling for ability. The approach was to discover, through linear discriminant analysis, the pattern of test scores that most effectively differentiated Project TALENT 11th graders who were in science jobs 11 years after high school from those who were not in science jobs.

Objective 2: Identification and measurement of nonability variables that are predictive of establishment of a career in science for individuals with equal Scientific Potential. The achievement of this objective provides us with new understanding of the career developmental process that results in the ultimate utilization of the scientific abilities that high school students possess. The approach was to compute and analyze partial correlations of 374 personal characteristics of Project TALENT 11th graders with establishment of a science career eleven years after high school, after first partialing out Scientific Potential.

Objective 3: Comparison of differences in Scientific Potential and its relationships to science career plans, among whites, blacks, Orientals, and Spanish surname students, between males and females, and among urban, suburban, and rural high school students. The achievement of this objective is the first step towards understanding the problems of unequal access to careers in science. The approach was to test and question 1,142 high school students from various backgrounds in various locales throughout California (as qualitatively representative of the pluralistic American society). The results were compared, where possible, with the data from the Project TALENT testing in 1960, to discover trends over the last 15 years.

Objective 4: Identification and measurement of knowledge, about science careers and about one's own abilities and motivations, that is related to the realization of high school students' Scientific Potential through planning for a career in science. This and the following objectives include comparison of results across the various groups of students referred to in Objective 3. The achievement of this objective provides the basis for recommendation of types of informational aids that are most likely to help students to make career plans appropriate to their levels of Scientific Potential. The approach was to develop a questionnaire in which students' estimates of career attributes and their own traits could be observed, and to compare the results with information about careers available from Project TALENT and with the students' actual test and inventory scores.

Objective 5: Determination of the extent to which career development problems are due to misconceptions of career development and can therefore be solved by providing instruction in this area in high school. The approach was to include in the questionnaire prepared for Objectives 3 and 4 questions about the students' opinions concerning what the components of career development are and why they are important.

Objective 6: Identification of sources of influence and knowledge related to career development. The achievement of this objective allows us to determine what kinds of communication are likely to have the greatest impact on planning for science careers. The approach was parallel to Objective 5, to include appropriate questions in the instrument to assess students' career development for science.

Objective 7: Provide the foundation for developing a procedure for evaluation of the effectiveness of high school programs in terms of their guidance of students towards careers appropriate to their scientific ability potential. The procedure of administration of a questionnaire on career development to high school students (a copy of the questionnaire is contained in Appendix D) along with a test designed to assess their ability potential for ience careers provides the basis for achieving the objectives listed above; this procedure can also serve as an assessment of the effectiveness of the career education and career guidance programs the students may have encountered. Such a procedure could be applied to various innovative programs in order to select the most effective techniques for wide-scale implementation.

1.3 Project TALENT--A Brief Overview

This report represents a step in the pursuit of the long-range goal of understanding the adolescent-adult development process through longitudinal analysis of the information provided by the 400,000 Project TALENT participants--the student body of almost 5 percent of the high schools in the United States in 1960. These individuals, with two days of testing in the spring of 1960 and with follow-up responses over the next 15 years, have contributed, collectively, time equivalent to over 3,000 work-years and have provided over one-half billion bytes of information; the Project TALENT research staff has endeavored to convert this information into useful knowledge for the career development and educational development of the next generation. In the course of the last 15 years there have been numerous studies using Project TALENT data that are of relevance to science career development (Astin, H. S., 1967, 1968, 1970; Cooley, 1963, 1966; Cooley and Lohnes, 1968; Flanagan and Cooley, 1966; Lee, 1974; Lohnes, 1966; Shaycoft, 1975; Skypek, 1975). The current study, however, is the first to combine analyses of the TALENT follow-up data with analyses of data on current high school students and to utilize so extensively the 11-year follow-up responses.

Project TALENT was undertaken primarily because of the leadership and foresight of John C. Flanagan. His initial design and the problems in development of such a massive project are described in Design for a Study of American Youth (Flanagan, Dailey, Shaycoft, Gorham, Orr, and Goldberg, 1962), which the reader who wishes details beyond this overview should consult. The initial sample of high schools in that study was drawn to be representative of the entire nation, and all the students in grades 9 through 12 were tested in each school in the sample. The testing consisted of a battery of ability tests, a test measuring information in various content areas, an inventory of career-related interests, and almost 400 items of information on the family, the high school experiences, and the plans of the students. Each student was contacted by mail one year after his or her expected high school graduation, five years after scheduled graduation, and again 11 years after. Although there has been significant attrition due mostly to lost forwarding address but partly to anxiety about providing personal information, over 100,000 participants have responded to the 11-year follow-up. In order to correct for nonresponse bias, 10,000 of the 300,000 nonrespondents have been the subjects of an intensive search and have been asked to give an interview by telephone, with a success rate of over 80%. The follow-up questionnaires have included questions on education, careers, family activities, opinions about their jobs and quality of life, and evaluations of the contributions of their high school education to their lives.

In the course of this Scientific Career Development Project, analyses have been restricted to a subset of the Project TALENT data that have been collected: the respondents to the 11-year follow-up of the students who were in the 11th grade in 1960. These are 23,700 individuals, of whom about 5,000 had plans to pursue science careers when in high school and 1,200 were in science occupations 11 years after high school. The responses of each individual have been weighted appropriately* so that the results are generalizable to all students in the 11th grade in America in 1960, not merely

*Project TALENT Follow-Up Regression Weights C--see The Project TALENT Data Bank Handbook, Wise, McLaughlin, Shaycoft, and Steel, 1976.

to those who would choose to respond to the follow-up. The cost in precision (greater standard error) this differential weighting introduces is more than offset by the increase in validity resulting from the reduction of response bias to a minimum.

The crucial pieces of information used from each follow-up respondent's returned questionnaire were his/her statements of "job held on September 1, 1972" and of level of education achieved. These data were used to divide the sample into two subsets: those who had established scientific careers by age 29 versus those who had either established other careers or had no paid job. The specific definition of "scientific career" developed for this project is described in Chapter 3.

1.4 Scientific Career Development Project--A Brief Description of the Collection of New Data

Sample. The sample consisted of 1,142 students in the 10th, 11th, and 12th grades at 11 high schools in California. There are, to our knowledge, no special programs for science career development that are peculiar to California. Based on the TALENT data collected in 1960, California students displayed the same mean level of abilities as the rest of the country, and the same proportion of them had science career plans in high school. The numbers of students in the sample, by school, grade, race, and sex, are given in Table 1.1. The schools were chosen to be qualitatively representative of high schools across the country. Accordingly, schools from large metropolitan areas, smaller cities, suburban, and rural areas were included, and students of minority groups were represented in sufficient numbers to permit meaningful comparisons among the several cultures. Within each school, students were chosen who would be representative of the population of the school rather than of the students in science courses. (See Appendix A, "Selection of the 1975 Sample.") For the students chosen, participation was voluntary, but no students refused to participate. Students were specifically instructed that they need not answer any questions that they did not wish to answer and that participation was not related to academic credit. Permission was received from the parents of each participant for his or her participation.

Because the objective of this data collection was not to compare these schools or any programs in them, no attempt was made to equate the samples

Table 1.1

Numbers of Students in the 1975 Sample by School, Sex, Racial/Ethnic Group, and Grade

School	Kind of Community	Female	Male	American Indian	Black	Oriental	Spanish Surname	Other White	Other	No Response[a]	Total
1	suburban	47	47	4	0	2	19	66	3	15	109
2	suburban	48	54	0	0	4	0	96	2	0	102
3	rural	41	43	1	0	1	1	74	7	5	89
4	rural	37	43	3	1	8	20	44	4	6	86
5	outer urban	56	30	2	17	8	3	49	7	2	88
6	inner urban	63	84	3	15	9	52	60	8	20	167
7	outer urban	69	45	1	1	11	5	89	7	2	116
8	inner urban	26	27	0	7	4	26	13	3	1	54
9	inner urban	62	36	1	5	3	85	2	2	21	119
10	inner urban	52	37	8	77	0	2	0	2	11	100
11	suburban	53	55	1	0	6	3	97	1	4	112
Grade											
10th		250	221	15	54	29	93	257	23	39	510
11th		180	144	6	45	18	67	176	12	26	350
12th		109	120	3	21	8	37	149	9	16	245
No response		15	16	0	3	1	17	8	2	6	37
		554	501	24	123	56	216	590	46	87	1,142

[a]Cases where either sex or ethnic group membership is missing.

across schools. The differences among schools that are discussed in Chapter 4 must be considered as purely tentative and exploratory, and any suggested effects need more controlled comparisons for verification. The interpretation of racial and other effects must be qualified by the fact that they are, or may be, confounded with specific school effects; for example, most whites were in schools in which most of their fellow students were whites, and most minority students were in schools composed primarily of the same minority. Nevertheless, because the schools are qualitatively representative of the majority of schools across the country, the differences observed here among races and among other groups appear to warrant qualified generalization.

A major subtask of the data collection was the achievement of guarantees of cooperation from the school staff at each participating school.

A few schools, when approached for participation in the study, found themselves unable to participate. (In one case, the decision was reversed several times by different review committees, and participation was still being considered by them until after the data collection phase of this project had been completed.) Nevertheless, 11 of the 14 schools approached agreed to participate, each providing approximately 100 students for five classroom hours. We believe the reason for the high acceptance rate was that the project design included provision both for collecting the data necessary to meet the project objectives and for providing the participating students with a career guidance experience.

As a part of the procedure, students took tests designed primarily to assess their Scientific Potential (see Section 3.3). However, these tests also provided information necessary to generate profiles of abilities and interests, and these were returned to the students, who could compare their scores to the profiles of Project TALENT participants who were pursuing various careers. Accordingly, one additional hour of the subject-contact time was set aside for presentation of The Career Data Book (Flanagan, Tiedeman, Willis, and McLaughlin, 1973), which contains such career profiles, and we developed a computer system that generated students' profiles from test scores in the few days intervening between test administration and the career guidance session. Counseling personnel at the schools were involved in this process, and students were in general delighted to have access to such potent career planning data. It should be noted that special precautions were taken so that students would not overinterpret their scores. The nature of test errors was pointed out to the students, and it was emphasized that abilities could be developed and could change. The students were not presented with any scores that could be construed as "extremely low"; instead, these scores were lumped with the "somewhat low" scores. An example of a student's profile computed in this manner is shown in Figure 1.1.

The Career Planning Survey and the test battery. Two instruments were developed for the data collection: a questionnaire that addressed the content of Objectives 3, 4, 5, and 6 and an adaptation of the Project TALENT tests that was necessary for the calculation of the Scientific Potential index and for the determination of student profiles to be matched to profiles in The Career Data Book as described above. The questionnaire (which appears

STUDENT CAREER PROFILE

NAME:
SCHOOL:
GRADE: 10

DAY OF TESTING: 03/10/75
TESTING NUMBER: 1002

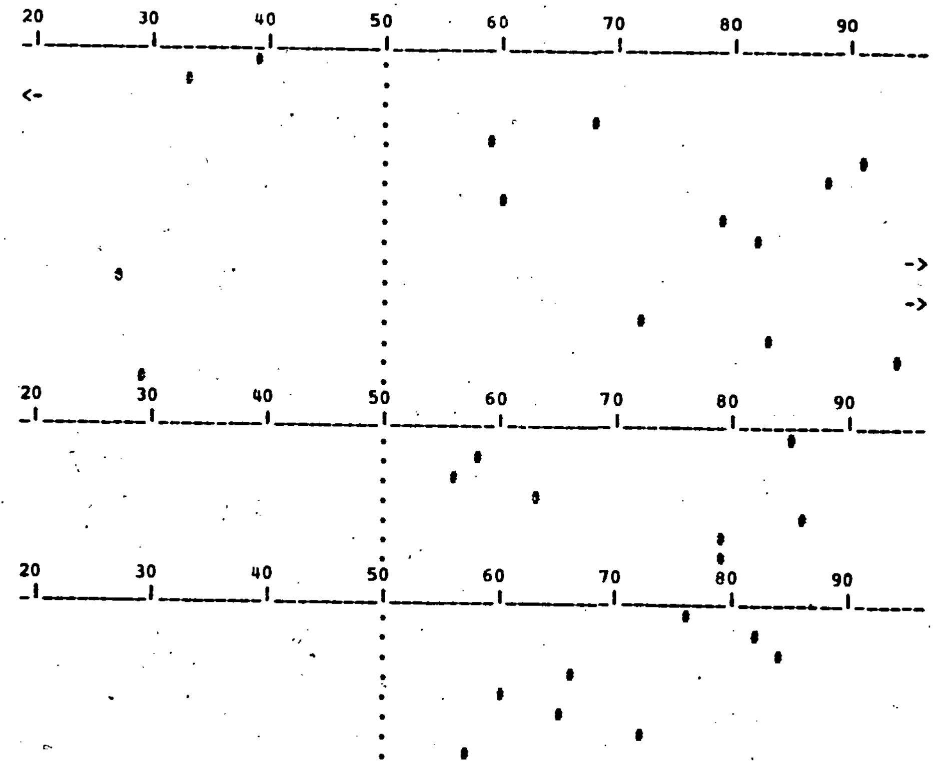
SCALE NAMES

<u>INTEREST SCALES</u>
PHYS. SCI., ENG., MATH.
BIO. SCI, MEDICINE
PUBLIC SERVICE
LITERARY-LINGUISTIC
SOCIAL SERVICE
ARTISTIC
MUSICAL
SPORTS
HUNTING & FISHING
BUSINESS MANAGEMENT
SALES
COMPUTATION
OFFICE WORK
MECHANICAL-TECHNICAL
SKILLED TRADES
FARMING
LABOR

<u>INFORMATION TESTS</u>
VOCABULARY
LITERATURE
MUSIC
SOCIAL STUDIES
MATHEMATICS
PHYSICAL SCIENCE
BIOLOGICAL SCIENCE

<u>ABILITY TESTS</u>
TOTAL ENGLISH
READING COMPREHENSION
CREATIVITY
MECHANICAL REASONING
VISUALIZATION IN 3D
ABSTRACT REASONING
ARITHMETIC REASONING
INTRODUCTORY MATH

PERCENTILE SCORE *



* A PERCENTILE SCORE TELLS YOU ABOUT WHERE YOU SCORED IN RELATION TO OTHER PEOPLE. FOR THIS PROFILE, YOUR SCORES ARE COMPARED TO THOSE OF ALL PEOPLE WHO WERE TENTH GRADE STUDENTS IN 1960. FOR EXAMPLE, IF YOUR PERCENTILE SCORE IS 50 FOR SOME SCALE, YOUR SCORE IS HIGHER THAN THE SCORES OF 50 PERCENT OF ALL TENTH GRADE STUDENTS WHO WERE TESTED IN 1960. YOUR SCORES ARE <u>NOT</u> EXACT MEASURES OF YOUR INTERESTS AND ABILITIES. ON A DIFFERENT DAY YOUR SCORES MIGHT BE AS MANY AS 20 PERCENTILE POINTS HIGHER OR LOWER.

IF YOUR SCORE IS MARKED BY:
\# THEN YOUR SCORE EQUALS THE NUMBER OF THE COLUMN THAT IT IS PRINTED IN.
<- THEN YOUR SCORE IS BELOW 20.
-> THEN YOUR SCORE IS ABOVE 95.

AIR/NSF - 1975

Figure 1.1. An example of a student's profile from the 1975 sample.

in full in Appendix D) contains seven types of items: (1) career and educational plans (Questions 1, 2, 3, 7, 8, 9, 18, and 35 through 40), (2) knowledge and attitudes about careers (Questions 4, 6, 19, 20, and 56 through 62), (3) perceptions of influences on their career plans (Questions 5, 15, 23, 24, and 26 through 34), (4) estimates of their own abilities, interests, and values (Questions 10 through 14 and 46 through 52), (5) knowledge and attitudes about the career development process (Questions 16, 17, 21, 22, and 25), (6) information about perceptions of the school and community (Questions 53, 54, and 55), and (7) information about various background factors that, on the basis of previous research, are likely to be related to entering a scientific career (Questions 41 through 45, and the unnumbered questions prior to Question 1). For most of the items, Appendix D includes four statistics: the frequency of each response, the proportion of those giving each response who were planning to pursue a scientific career, and the mean Scientific Potential of those giving each response who were and were not planning scientific careers.

Except for the questions concerning background factors, which were taken from items on the Project TALENT Student Information Blank and follow-up questionnaires, all of the items were developed by the project staff. Consideration of the previous literature led to the conclusion that there was no instrument available that would provide the information needed to achieve the objectives of the project.

In addition to developing the questionnaire, the staff adapted the Project TALENT battery for the purposes of this project. The intact battery could not be used because of its length, requiring about one and a half days to complete. The version used was a subset taking about two and a half hours to administer. The component tests of the full battery are described in detail in <u>Design for a Study of American Youth</u> (Flanagan et al., 1962) and more briefly in <u>The Career Data Book</u> (Flanagan et al., 1973) and in <u>The Project TALENT Data Bank Handbook</u> (1976).

Three criteria were used in selecting the tests for this abbreviated battery. First, the tests were selected to provide the data necessary for computation of the Scientific Potential index. The second consideration was ease of administration, particularly the time required. (This precluded, for example, taking a few items from each test, since they all had separate directions to be read.) Finally, in return for taking these tests, the students were to receive their own ability and interest profiles in a form that could be compared to the profiles in The Career Data Book. Thus one additional constraint was that the test battery had to be constructed so that scale scores similar to those in The Career Data Book could be generated with reasonable accuracy. The specific goals and the resulting abbreviated test battery are described in Chapter 3 and particularly Table 3.12.

The tests and questionnaire were administered to the students in each school in classroom-size groups. The tests were administered as the first component of the procedure, followed by the Career Planning Survey. The career guidance session occurred approximately one week following the initial testing, allowing time for coding and keypunching of test answers and for computer profile generation. Although each student participated for a total of six hours, the number of days students were involved differed across schools based on the desires of the participating school staff for a minimally disruptive schedule.

1.5 Summary

This report addresses the question of what actions are most likely to help high school students pursue careers that are appropriate for their levels of science ability. Two approaches to this question were undertaken: collection of new data on the types of relevant knowledge that today's high school students lack and analysis of the characteristics of Project TALENT participants who have successfully established scientific careers. A model was developed for the separation of career development factors from the general scientific ability factor in the determination of pursuit of scientific careers. An index of Scientific Potential was developed on the basis of comparison of the ability differences between Project TALENT's scientists and other respondents to Project TALENT's questionnaires.

The specific objectives of this study were (1) development of an index of abilities typical of people in science careers; (2) identification and measurement of nonability factors that are correlated with successful establishment of a scientific career when abilities are equated; (3) comparison of scientific abilities and plans for science careers across race and sex

boundaries; (4) assessment of the knowledge students have about themselves and about careers that is necessary for good career development; (5) assessment of students' knowledge about the career development process; and (6) identification of the sources of influence and knowledge concerning career development. These assessments were designed for students in a high school setting, and a subsidiary objective of the study was to provide the foundation for developing a procedure for evaluation of the effects of high school programs on career development with respect to scientific careers.

The foundation for this study was provided by Project TALENT, a study of 400,000 individuals who were in American high schools in 1960 and who have been followed up periodically since then. Of the subset of the Project TALENT participants whose responses were used in this study, over 1,200 were in scientific occupations when contacted in 1972. The Project TALENT data were supplemented by the collection of information related to the study's objectives from a sample of 1,142 students in 11 high schools during the spring of 1975. These two data sources provide the basis for the results presented in the third and fourth chapters: the development of the index of Scientific Potential (Chapter 3) and the correlates of the development of scientific careers (Chapter 4).

CHAPTER 2

Theoretical Framework of the Study

2.1 The Role of Abilities in the Development of Scientific Careers

Because science will be confronting ever more complex and difficult problems, it is essential that the individuals who become scientists possess exceptional problem-solving abilities. The set of attributes that most clearly differentiate potential scientists from other high school students is the level and pattern of developed cognitive abilities (see Rever, 1973, for an excellent review). Whether because of genetic differences, environmental factors, parental actions, or particular reactions to the experiences of schooling, individuals when they reach the high school years have developed the abilities appropriate for scientific careers to widely different degrees. Those students who by the middle of their high school years have not developed the abilities that will be needed for science to a level beyond that of their peers will be at a distinct disadvantage in the ensuing period of preparation for science careers and will be much less likely to complete educational training programs for science and survive the competition for the relatively small number of openings for professional careers in science.

Abilities measured in high school are not the only determinants of successful establishment of a scientific career, nor are these measured ability levels immutable. For the purposes of this analysis, however, it is instructive and clarifying to separate ability factors from others that we shall call career development factors in the study of determinants of science careers. Indeed, some career development factors may affect career choices by providing motivations that lead students to develop their abilities beyond their previous relative standing in high school.

In order to isolate the influences of the career development factors that affect an individual's likelihood of pursuing a science career, it is necessary first to control for abilities; that is, it is necessary to compare the attributes and experiences of scientists with others of equally developed abilities for science careers who did not pursue careers in science. Otherwise, factors will appear to be important merely because of their correlations with abilities. Furthermore, if actions are proposed that would influence high school students' desires for science careers without necessarily changing their abilities, these actions should be undertaken only with knowledge of whether the students' abilities are appropriate for science careers; otherwise, a well-intentioned action could cause more harm than good. For these reasons, an initial step in this project was to devise an index of Scientific Potential, an ability composite, that could be determined for each high school student.

The data from the 11-year follow-up of Project TALENT, which became available in the middle 1970s, provided the investigators with a unique opportunity to develop an index of abilities necessary for successful establishment of careers in science. Previous endeavors have been limited either by reliance on short-term critiera such as successful completion of a college science major (e.g., Reid, Johnson, Entwisle, and Angers, 1962), or by reliance on data gathered only after individuals had established their careers (e.g., West, 1961), or by limits in sampling among scientists or the comparison group. The Project TALENT respondents have provided us with data that are not subject to these limitations: at age 29 they have passed through the initial stages of science career development, two days of test scores are available from their high school days in 1960, and (with appropriate statistical weighting) they represent the entire range of American high school students in 1960. On the basis of these data, the Scientific Potential index was developed as the answer to the following question:

> Among Project TALENT participants who were in the 11th grade in 1960, what device can be developed that would most accurately distinguish the abilities of those in science jobs in 1972 from the abilities of those not in science jobs using data from 32 cognitive ability tests taken in 1960?

Specifically, the index was computed as a two-group linear discriminant function, and recognizing that being in a science job is not the best of criteria when considered alone, the authors validated the resulting Scientific Potential index in terms of several measures of success as a scientist. The details of the definition of "science," of the computation of the Scientific Potential index, and of its validation are presented in Chapter 3.

It was necessary to restrict the sample to males during the development of the Scientific Potential index because of the scarcity of women in the sample who were in science jobs and because of large sex differences in the types of jobs possessed within the science profession. It is our assumption that the same abilities are needed by members of both sexes in order to succeed in science. The focus on male data is justified by the fact that fewer irrelevant barriers stood in the way of male science career development than in the way of females, so that the male career development was more "natural" and more likely to be predictive of the future for both sexes. In Chapter 4, tables are presented for women, as well as for men, showing the types of jobs those with high Scientific Potential held at age 29, in 1972.

In high school, some students have career plans for science; others do not. Among students with science career plans, ability plays the central role in determining ultimate establishment of a science career. Previous studies have indicated that the principal difference between male high school students who followed through on their plans for scientific careers and those who redirected their careers away from science was the possession of the requisite abilities to survive the inevitable competition during college and during the search for employment in science careers (e.g., Reid, Johnson, Entwisle, and Angers, 1962; Cooley, 1963). Among students without science career plans, ability shares the central role of determining ultimate establishment of a science career with factors leading to the later development of science career interests. Therefore, restriction to the population of high school students already having science career plans provides the purer ability-discrimination between those ultimately establishing science careers and others; as a result, a purer Scientific Potential measure can be obtained for this restricted population than for the total high school population. Although, by construction, only ability measures were allowed to enter into the Scientific Potential index, some of these ability measures may be more closely related to career development factors than others. To have included all high school students in the computation might have confounded ability requirements for science careers with career development factors. (In order to make a partial check on these assumptions, the computation was performed both ways, on all male students and on only those who planned science careers, and the results were very similar. The comparison of these computations is presented in Chapter 3.)

The global model for the process of science career development in high school underlying this approach is shown in Figure 2.1. The inclusion of individual background factors, scientific abilities, and science career development actions in the prediction of the establishment of a career in science is straightforward. The present model, however, separates career development knowledge as a particular set of factors whose role is to be investigated in the establishment of science careers. The knowledge of oneself, of occupations, and of the career development process is an important link between the input factors of background and abilities and the output factors of movement toward scientific careers. Misinformation in any one of the three areas can prove to be a critical barrier to entry into science.

Individual background variables are factors difficult to change. Interventions can, however, be undertaken to minimize potential negative effects of these variables on science career development. For example, the schools can provide role models not provided by parents, and carefully developed tests of abilities can counteract earlier misconceptions concerning one's fitness for a scientific career. It is more difficult, although

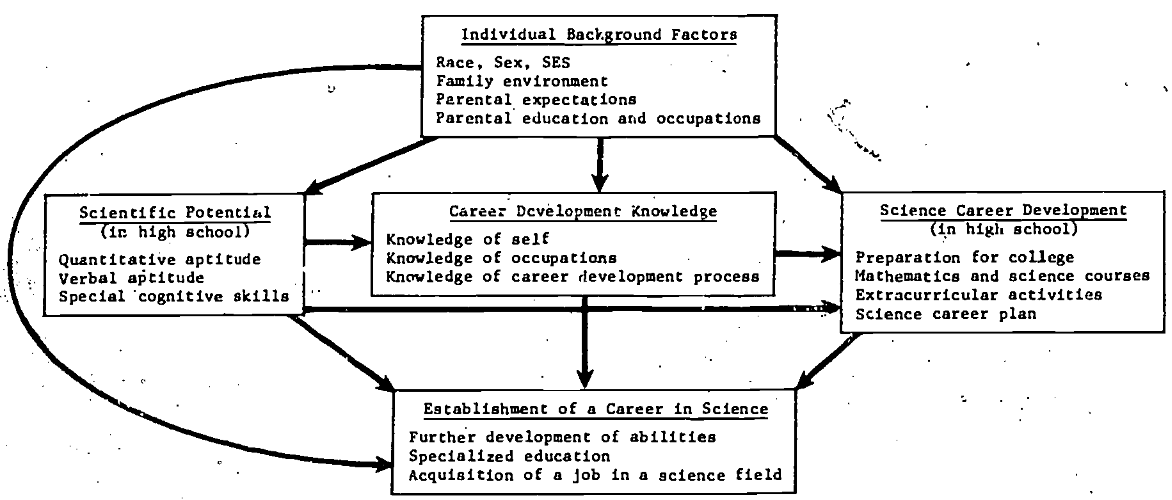


Figure 2.1. A model of the interactions among Scientific Potential and the career development factors affecting the establishment of a career in science.

feasible, to change Scientific Potential than to change occupational interests or particular knowledge deficits. Students' abilities are measured relative to a group norm, and a sufficiently motivated individual can always increase his or her standing relative to the group. The science career development process is depicted in Figure 2.1 as a two-stage process: during high school and after high school. This dichotomization is made in order to focus the activities of this project on the high school years, using ultimate establishment of a science career as merely a criterion measure for the analyses. Likewise, pre-high school variables, while they contribute to the development of Scientific Potential, are not included in the model in order to limit the scope of this study and concentrate on a particular age-period.

The development of the Scientific Potential index was based on an attempt to isolate roughly the abilities contributing directly to the establishment of a career in science. In order to estimate these ability contributions, it is necessary to control for indirect relations between abilities and science career establishment. For example, if a particular ability were predictive of planning a science career but completely unrelated to actual establishment of a science career by those planning one, then there would appear to be a relation between that ability and science career establishment even though there were no direct relationship between the two. On the other hand, if we were to control for all background and nonability differences, the problem would arise that we would have accounted for nearly all of the reliable variance in ability test scores. In that case, the derived Scientific Potential index would lose a great deal of its reliability. A compromise appears essential, in which the Scientific Potential index would consist of abilities contributing to establishment of a science career for groups relatively homogeneous on nonability factors related to science careers. In the present study, the groups were homogeneous on (1) sex and (2) the presence of a plan for a career in science.

The decision to develop a unidimensional index of Scientific Potential is based on the assumption that, at the high school level, similar abilities are needed for development toward any science and that differentiation among specialized abilities for particular fields of science emerges later. This assumption is clearly a topic for future steps in a research program on scientific careers. The decision to calculate such a function at all was based on the further assumption that the abilities predictive of entry into and establishment of a science career during the late 1960s and early 1970s are, in the main, similar to the abilities that will be needed by today's high school students as they pursue careers in science. In summary, this index is intended to provide a foundation for clearer analyses of the career guidance factors that affect the development of science careers than would otherwise be possible.

2.2 Science Career Development Processes in High School

According to Rever (1973), "a two-dimensional space is necessary to describe career paths during the high school years," the more predictable one being a "college-other continuum" and the second being a "directional one from physical...science...to arts and humanities...." (p. 138). During high school, the potential scientist will manifest his or her interest in two ways that are important, if not crucial, to the pursuit of a career in science. The first way is by doing those things that will enhance his or her opportunity for a college education. College is the training area for scientists, and only extremely gifted and motivated individuals will be able to pursue a career in science without having graduated from a reputable college. Although the availability of higher education is steadily broadening so that more members of society may benefit from its effects, competition will continue to be very stiff along the paths to science careers; high school students who gain entry into the colleges that are especially successful in training scientists are clearly more likely to develop their scientific potential. The second way high school students manifest their interest in science careers is to take steps to gain the knowledge of mathematics and science that will allow them to make the most of their initial science courses in college. College courses, especially in science, are designed to transfer as great an amount of information and understanding in each semester as possible, and those students who are best prepared prior to the courses are most likely to grasp the deeper significance of the exercises they perform and therefore to become even better prepared for a science career as they progress to college junior and senior status. Thus, high schools that interest students in taking more science and math courses will produce individuals who are more likely, in the end, to translate their scientific potential into actual careers as scientists.

The role of high school personnel in these two processes is critical, and students must rely on them to facilitate science career development. However, Finkel (1961) found that high school principals were more interested in keeping "unqualified" students out of science than in guiding potential scientists; and Morrison (1970) concluded that physical science courses discourage more students than they attract except for high ability boys. If high schools are to play a role in increasing the opportunities for women and minorities to establish careers in science, special efforts will be necessary to nurture their development during high school.

In addition to these objectively observable steps toward a career in science, there are other processes of career development that occur during the high school years. The most observable of these is the development of <u>an expectation of becoming a scientist</u>, that is, the translation of vague ideas about science into a vocational decision to pursue a particular type of career. This expectation provides motivation and direction for a student's high school activities and later becomes important as a context for choice of courses in college. The development of this expectation is probably the most easily influenced factor in the development of a high school student's scientific potential.* A student's expectation of a science career is in turn based on information about some field(s) of science and on a self-image that is related to the image of a scientist, whether that information is objective, is from role models, or is from cultural stereotypes.

Another career development process that is important for a science career and that is initiated or continues during high school is the acquisition of <u>values and attitudes that are characteristic of successful and productive scientists</u>. Among these values and attitudes are:

- enjoyment of solving inductive and deductive problems,
- enjoyment of being precise,
- enjoyment of acquiring knowledge;
- a general need to achieve, and

---

*There is an ethical question of how much external influence is appropriate. The assumption is, however, that because there is potential for influence, the importance of this factor should be investigated.

- a commitment to honesty in the sense of unbiased interpretation and presentation of information.

Although these are not abilities, and therefore do not enter into the Scientific Potential definition, they may be correlated with Scientific Potential, since both arise from similar individual background factors, such as an intellectually rich home environment. Unlike the preceding processes, these value and attitude development processes are beyond the scope of the present report.

In many of the analyses presented in this report, science career development in high school is represented by the single indicator of whether the student's stated career plan is a scientific career. This indicator is well known to be the best single predictor of pursuit of a science career (see Rever, 1973, p. 144), and as such it is a sufficient indicator for what is a complex, incremental process, when the focus of analysis is the factors affecting the developmental process rather than the process itself. Using this indicator of science career development in conjunction with the Scientific Potential index, the authors have investigated the career development factors that affect whether students develop careers appropriate to their scientific potential levels.

2.3 Factors Affecting Career Development

In order to develop a model for the types of information high school students need to know to make adaptive career plans with respect to science, we posit two principles that relate students' perceptions to their career plans:

1. Youths will tend to explore and pursue careers that have reinforcement and reward systems they perceive as congruent with their own motivations; and

2. Youths will tend to explore and pursue careers that have skill requirements they perceive as congruent with their own abilities.

Adaptive career planning requires that youths develop accurate perceptions of values and skills typical of themselves and of careers. Arrayed against adaptive career planning are the various factors that tend to direct career development in nonrational ways: parental expectations, peer pressures, misinformation, racial and sex stereotyping and discrimination, and glamorized and stereotyped career role descriptions in mass media presentations.

The types of information high school students need in order to apply the two principles of career planning are:

- the pattern of rewards that are to be expected in various careers;
- the pattern of skills required for success in various careers;
- one's own pattern of values and needs;
- one's own pattern of abilities; and
- an understanding of the career development process.

A primary objective of the current project was to develop an instrument to assess these five areas of information, to determine whether, indeed, they are crucial to appropriate career development with regard to scientific careers, and whether deficiencies in these areas might contribute to racial and sex stereotyping of science careers. If individuals with high Scientific Potential in groups that are underrepresented in science careers tend to be deficient in one or more of these knowledge aspects, straightforward steps can be taken to remove the deficiencies.

Information about reinforcements and rewards to be expected in various careers is available from many career guidance sources (e.g., The Occupational Outlook Handbook). This information, however, nearly always suffers from three deficiencies: (1) it is based on interviews with small numbers of people in the careers and may not be representative of the typical career member; (2) it is based on the reports of people in occupations who are usually middle-aged and requires high school students to guess how their own values will change over the period of a decade or more; and (3) it is based on reward systems of the present and requires students to guess how rewards may change over the next two to four decades.

Although the third problem is essentially insurmountable, and we can do no better at present than to assume that rewards will not change much, the first two problems can be addressed by a large-scale longitudinal study such as Project TALENT. It is possible to estimate the components of job satisfaction that are typical of various careers that the Project TALENT participants pursue and to relate them to statements about job values and interests made by the same individuals while in high school. For example, McLaughlin (1975) found that on two important dimensions of reward, "income" and "doing worthwhile work," ratings of their importance varied systematically for 29-year-olds in different careers, and their patterns of ratings were the same as ratings obtained from those individuals in high school. If such stability of values is a general phenomenon, then the problem of interpretation by high school students of older individuals' perceptions of career rewards may not be serious. The question clearly needs further exploration.

Information about skills required for success in various careers has been published in many sources but typically suffers from the same deficiencies as information on career rewards: small data bases, made up of adults who have pursued the career for a number of years. In response to these first two problems, information on the abilities of high school students who were pursuing various careers five and eleven years after high school graduation have been published by Project TALENT (The Career Data Book, Flanagan et al., 1973; Using the TALENT Profiles in Counseling: A Supplement to The Career Data Book, Rossi et al., 1975) for use in high school career guidance. The problem of determining how skill requirements for careers will change in the next two to four decades has no solution in sight.

Information about an individual's own values, needs, interests, and abilities is, in a sense, immediately available to him or her, since it can be gained from self-perception and introspection. Why, then, the need for standardized tests and inventories? The reason is that the information must be provided relative to a population; through normative data an individual is likely to learn more about the comparison population than about himself or herself. Information relative to a population is especially necessary in the case of abilities in order to judge how difficult it will be to compete for a job one might desire. Abilities are continually being developed in childhood and adolescence so that, to each individual, his or her abilities appear in general greater than those of younger students and less than those of older students, and the differences at one's own age level seem smaller. Moreover, one's comparison of himself or herself with peers is almost always limited to a small group of classmates. Any comparisons made without benefit of standardized tests are likely to mislead students.*

In the case of values, needs, and interests, information relative to a population is necessary to establish the scale's meaningfulness. When considering characteristics of occupations, a student may be more interested in "helping others" than in "office work," say, on an absolute comparison, when in fact his interest in helping others is at the 50th percentile relative to the population and his interest in office work is at the 90th percentile, because nearly everybody tends to express more interest in helping others than in office work. Such a student would clearly benefit more from a career involving a great deal of office work than the typical person, other things being equal.

Although Super (1963, 1973) has pointed out the importance of gaining an operational understanding of the role of the self-concept in career development, only a small amount of research has evaluated the accuracy of subjective self-evaluations in relation to actual test scores. Crosby and Wisner (1941) observed correlations of between .4 and .6 for six Kuder interest scales. In a more extensive study, O'Hara and Tiedeman (1959) have reported correlations between self- and test evaluations for 37 scales of aptitudes, interests, and values for each of four high school grades. Although the correlations were significantly positive, they were small enough to suggest that students cannot rely completely on self-estimates. However, some correlations were substantial (greater than .6), implying that self-estimates could indeed be valuable for selected variables.

Whether or not self-knowledge is accurate, there is evidence that self-estimates of ability are effective determinants of career plans. O'Hara (1967) found self-estimates more closely related to career plans than were actual aptitude scores. Tuck (1972) tested whether unrealistically high and

*There are some grounds for the reverse argument, that a student's standing relative to his or her classmates may be a better indication of potential than a nationally standardized score. One's immediate peers may significantly affect the effort one expends to develop his or her abilities, so that, for example, a youth with a nationally standardized ability percentile of only 60 who is performing at a higher level than any of his or her immediate peers may be in fact indicating the potential for a much higher ability score if a change of environment is interposed.

low vocational aspirations were related to over- and underestimates of abilities, respectively; the correlations of the tendency to "overaspire" with the tendency to overestimate abilities were significantly positive, although not particularly large (the largest was .33). Tuck concluded that since self-knowledge appeared to be related to realism of career plans, counselors who wish to foster realistic career plans should consider that testing might be necessary to provide students with accurate information about themselves.

In the past, most career choices have not been the result of careful career planning. Although, with the increasing emphasis on preparation for careers as a primary objective of public education in America, rational career choices are likely to be much more frequent, sound choices cannot be made by students who lack an understanding of the career development process. Students need to know that career development is a continual process rather than a single choice, and they need to become sensitive to the relationship between their actions and that process. Students need to know the importance of and methods for gaining and using relevant knowledge to evaluate career decision options. Finally, students need to be aware of the importance of trial and error in career development and of the ways of gaining knowledge and perspective from events that appear to be setbacks in career development.

In order to understand the necessity of knowledge about these aspects of career development, let us consider some possible results of an inadequate understanding of career development. If an individual believes career development to involve a small number of crucial steps rather than a large number of increments, he or she is likely to be very anxious about career decisions, to delay decisions excessively, and to be less likely to explore a wide variety of alternative career paths. If an individual is not aware of the relationships between his or her actions and career development, he or she is likely to take actions that preclude some viable career paths unnecessarily and is likely to fail to take actions that might open new career paths. If an individual does not understand the importance of gaining and using knowledge in career planning, he or she is likely to depend on vague impressions and guesses even though objective information is available. Finally, a lack of knowledge about methods for gaining and using career and self-information will also result in decisions based on vague impressions, even though the individual is aware of the importance of such knowledge.

An understanding of the role of each of these knowledge components in the career development of high school students is necessary if we are to design programs to increase the accessibility of careers in science to all individuals with high scientific potential. The current study was undertaken to develop that understanding.

2.4 Summary

According to the viewpoint that underlies the current study, scientific career development in high school consists primarily of (1) preparation for college, (2) acquiring mathematics and science knowledge, and (3) developing an expectation of becoming a scientist. The likelihood of students' tending towards a career in science depends on the perceptions they have of the match between their motivations and the reinforcements and rewards of scientific careers, and between their abilities and the skills required by those careers. Therefore, the knowledge students have of their own motivations and abilities, and of the skills required and rewards provided by careers, as well as of the whole career development process, is crucial to good career development.

CHAPTER 3

An Index of Scientific Potential

In order to investigate the relations between career guidance factors and development of scientific careers, it was essential to control for the abilities that affect science career development. The first step in the present study was to compute a Scientific Potential index, a combination of cognitive abilities assessed in high school that is most correlated with establishment of a career in science. An instrument was then developed that measured the Scientific Potential of the high school students in the 1975 sample. Subsequent analyses of nonability factors were then able to control for the individual levels of Scientific Potential.

This chapter describes the development of the index of Scientific Potential for high school students and of an abbreviated instrument designed to measure Scientific Potential. The index was developed from Project TALENT data that included 32 measures of aptitude and ability on 11th graders in 1972. The 32 measures were reduced to 8 principal components, and the index was defined as the linear combination of the eight factors that was most predictive of being in a science career among males who had had science career plans in high school. The definition of "science" careers and the exploration of alternative indices based on all 11th grade males, based on females, and based on a reweighting of the science careers is described further in this chapter.

The index of Scientific Potential was shown to be predictive of eminence within a science career as well as entry into a career. Measures of eminence including inclusion in American Men and Women of Science, the number of references in recent volumes of the Science Citation Index and the Social Science Citation Index, and prestige ratings of the undergraduate and graduate schools attended were all found to correlate with high school measures of Scientific Potential for TALENT 11th grade males who became physicists, chemists, or psychologists.

Finally, an abbreviated instrument, a subset of the larger TALENT battery, was developed. The instrument was designed to yield a measure of Scientific Potential nearly identical to the general index (a correlation of

94) and also to provide reliable feedback to students on a wider range of ability and interest dimensions. The composition of this battery and the information returned to the students are described more fully in Section 3.3.

3.1 Development of the Scientific Potential Index

The general approach taken in developing an overall index of Scientific Potential was to use the longitudinal data available in Project TALENT to relate abilities measured in high school to successful establishment of science careers by 11 years after high school graduation. The Project TALENT data base was an ideal source for these analyses, since it contains data on a representative sample of 1960 high school students with follow-up data at about age 29. Scientists in this group had just recently completed their education and begun their professional careers, so they represent the current population of young scientists of the 1970s.

Samples. While Project TALENT contains data on students in each of four grades in 1960 (9th through 12th), the analyses of TALENT data were restricted to students in the 11th grade. The follow-up data needed for the criterion measure were not available for the 9th and 10th grade samples at the outset of this project (the 11-year follow-up of these grades has since been completed). Further, the norms on many of the information and ability measures change noticeably from grade to grade. Restricting the analyses to a single grade is one way of avoiding the introduction of unwanted grade effects into the analyses, and the degree of accuracy obtained from a single grade was judged adequate for the planned analyses. The gains in reliability that would have resulted from an additional grade did not warrant the considerable expense of doubling the number of cases and making the measures comparable between grades. The 11th grade was chosen as most representative of the target population of 10th, 11th, and 12th graders.

For most of the analyses, the entire 11th grade male and female samples were used; however, in some of the analyses subsets of these samples were analyzed separately. The Scientific Potential index is an attempt to identify the abilities needed to become a scientist, but entry into a science career reflects interest in such a career as well as the required abilities.

In order to focus more closely on the requisite abilities, the discriminant analyses were performed on the subsample of 11th graders who had science career plans in high school, as well as on the entire 11th grade sample. By restricting the range of initial interest, the analyses should focus more closely on the abilities needed. On the other hand, the results from the restricted set might not apply to those who did not already have science career plans. The results on the restricted sample matched those on the whole sample quite closely, so it appears that the abilities possessed by scientists do not vary greatly between those with early science career plans and those who decide later on science careers.

Criterion measure. The criterion measure used, holding a job in a science field at age 29, is rather broad and does not measure the level of success in a science career. It is, however, a readily observable and almost totally objective measure. The application and interpretation of other measures of success (e.g., publications, salary, or place of employment) would vary widely from one science career to another. (A chemist and a physician with equal salaries are probably not equally "successful.") In order to validate occupational entry as a good criterion variable, measures of success in science careers were collected on a sample of TALENT participants in three specific science careers and correlated with the computed index. The findings from these data support the validity of using occupational entry as the primary criterion variable, since the index based on establishment of a science career was also predictive of success within a science career. (See Section 3.2 below.)

Perhaps the most critical problem in developing the Scientific Potential index was in defining what was meant by "science" careers. A two-way classification scheme was developed for sorting careers into different levels of "scientific-ness." The first classification was based on information concerning the amount of science education (physical, biological, and social) required for entry to the career, the degree to which such science training was used on the job, and the degree to which people in the career contributed to or at least kept up with advances in related fields of science. Four categories were used to classify people along this dimension. These were:

43

Group A. Science Researchers who had extensive science training and used it in their work. A substantial number of the people in these careers are making contributions to the advancement of scientific knowledge.

Group B. Science Practitioners who had extensive science training and used it in their work, but in a more applied manner. These people keep up with technical advances in their fields, but are not generally involved in research.

Group C. Science Technicians who had some science training. They generally work under the direction of researchers or practitioners, but they also may work in industry.

Group D. Others whose jobs do not require much science training.

The classifications were based upon judgments made by the authors after consulting references such as the Occupational Outlook Handbook. The career categories used were the TALENT 3-digit job codes (see Appendix F of The Project TALENT Data Bank Handbook, Wise, McLaughlin, Shaycoft, and Steel, 1976). Table 3.1 shows those occupations classified into Groups A, B, and C. A few of the TALENT 3-digit occupations contained no 11th grade 11-year follow-up respondents and were not classified. All other occupations were classified into Group D.

This classification scheme was in need of still further refinement. Some occupation labels, such as "chemist," cover a wide range of career levels, including people in each of the first three groups. For this reason, a second dimension, level of education, was used to qualify the career classifications. All persons who were classified as science researchers were reclassified as science practitioners if they did not have an advanced degree. Next, all persons classified as science practitioners who did not have a bachelor's degree were reclassified as science technicians.

Tables 3.2 and 3.3 show the numbers of men and women with science career plans in the TALENT 11th grade sample falling into each of the cells in the 4 by 3 (career by level of education) classification and in the final 2-level classification. For each cell the raw, weighted, and effective sample sizes are shown. The raw sample size is the actual number of respondents

Table 3.1

Classification of Occupations in Science Categories

Group A	Group B	Group C
Science Researchers	Science Practitioners	Science Technicians
Agricultural Scientist	Architect	Chiropractor
Anthropologist	Chiropodist	Dental Hygienist
Archeologist	Dentist	Efficiency Expert
Astronomer	Dietitian	Electronic Technician
Biochemist	Engineer (various types)	Laboratory Technician
Biologist	Optometrist	Medical Technologist
Chemist	Pharmacist	Nurse
Conservation Specialist	Physician (all types except Medical Researcher)	Occupational Therapist
Economist	Psychoanalyst	Physical Therapist
Educational Researcher	Psychiatric Social Worker	
Geologist	Research Assistant (in science field)	
Mathematician	Statistician	
Medical Researcher	Teacher - Math or Science (High School or College)	
Meteorologist	Veterinarian	
Microbiologist		
Other Clinical Scientist		
Other Social Scientist		
Pharmacologist		
Physicist		
Psychologist		
Sociologist		

to the TALENT 11-year follow-up. The <u>weighted sample size</u> is an estimate of the number of people from the target population (<u>all</u> 1960 11th graders) who are represented by the follow-up respondents. Each respondent has been assigned a weight, the number of people in the population that he or she represents, that corrects for differential 1960 sampling and participation ratios and for differences in the follow-up response rates (see Wise et al., 1976, for a more complete description of Follow-Up Matching Weights C). The <u>effective sample size</u> is a lower bound estimate of the number of equally weighted cases required to produce the same level of accuracy as was obtained with the differential weighting actually used. The effective sample size will always be less than or equal to the raw sample size, since differential weighting produces less stable results. (Differential weighting is required for producing essentially unbiased population estimates.) The effective sample size is used in evaluating the statistical significance of various results.

Table 3.2

Numbers of TALENT 11th Grade Students with Science Career Plans[a] in Each Career and Education Category

Educational Level	N[b]	Science Researchers M	Science Researchers F	Science Practitioners M	Science Practitioners F	Science Technicians M	Science Technicians F	Nonscience Careers M	Nonscience Careers F	Total M	Total F
Advanced Degree	Raw	89	13	340	27	11	5	532	125	972	170
	Wtd	3,207	879	16,877	785	236	125	28,689	3,775	49,009	5,564
	Eff	8	2	40	5	11	4	65	18	121	28
Bachelor's Degree Only	Raw	32	8	239	25	44	53	848	361	1,163	447
	Wtd	2,105	161	10,696	1,610	1,463	1,676	49,988	32,212	64,252	35,659
	Eff	5	8	33	4	6	7	102	60	143	76
No Bachelor's Degree	Raw	8	0	85	6	182	270	1,526	1,216	1,801	1,492
	Wtd	514	0	5,277	1,033	13,240	15,268	125,907	87,233	144,938	103,534
	Eff	2	0	12	2	21	36	219	157	248	187
Total	Raw	129	21	664	58	237	328	2,906	1,702	3,936	2,109
	Wtd	5,826	1,040	32,850	3,428	14,939	17,069	204,584	123,220	258,199	144,757
	Eff	15	10	83	10	37	45	377	225	500	279

[a]The definition of science career plans used in developing the index was more general than the definition used in subsequent analyses, including some careers classified as science technicians. In particular, the number of women with career plans in science shown in this table includes those planning a nursing career, but that occupation was not included in the definition of science career plans for later analyses.

[b]The raw N is the number of Project TALENT participants in each cell. The weighted N, "Wtd," is the sum of their individual weights and therefore is an estimate of the total number of all 1960 11th graders in the United States who would have been classified into the particular group. The effective N, "Eff," is the statistic to be interpreted as a lower bound of the sample size in evaluating the statistical significance of various results. The effective N is described more fully in the text.

The primary purpose of this classification was to differentiate between those individuals who manifested the successful development of the abilities required of a scientist and those who did not. While the definition of "scientist" has conventionally been restricted to careers in Group A, the abilities required in careers in Group B are quite similar. On the other hand, entry into a science technician career generally requires much less science ability and training than is required for entry into science researcher or science practitioner careers. For these reasons, the criterion measure used in developing the index of Scientific Potential was taken as being either a science researcher or a science practitioner (Group A or Group B) with at least a bachelor's degree at the time of the follow-up 11 years after high school graduation.

Ability measures. The two-day Project TALENT test battery administered in 1960 included ability and information tests, interest, personality, and

Table 3.3

Numbers of 11th Graders with Science Career Plans[a] in the Final Two-Level Classifications

Category	N[b]	Males	Females
Science researchers and practitioners with at least a bachelor's degree	Raw N	700	73
	Wtd N	32,885	3,434
	Eff N	85	10
All others	Raw N	3,236	2,036
	Wtd N	225,314	141,322
	Eff N	420	270
Totals	Raw N	3,936	2,109
	Wtd N	258,199	144,756
	Eff N	500	279

[a]The definition of science career plans used in developing the index was more general than the definition used in subsequent analyses, including some careers classified as science technicians. In particular, the number of women with career plans in science shown in this table includes those planning a nursing career, but that occupation was not included in the definition of science career plans for later analyses.

[b]The raw N is the number of Project TALENT participa[illegible] in each cell. The weighted N, "Wtd," is the sum of their individual weights and therefore is an estimate of the total number of all 1960 11th graders in the United States who would have been classified into the particular group. The effective N, "Eff," is the statistic to be interpreted as a lower bound of the sample size in evaluating the statistical significance of various results. The effective N is described more fully in the text.

background measures, and information on current activities. Thirty-two different ability and information scales were included in the analyses as possible predictors of later science achievement. There are high correlations between many of the 32 cognitive tests, and highly correlated variables lead to unstable (from sample to sample) discriminant functions. (The correlations between the 32 tests are given in Table 3.4.) Also, a smaller number of factors would be more meaningful to other researchers who do not have access to the TALENT tests. Therefore, principal components of the 32 tests

Table 3.4

Intercorrelations among the 32 Ability Measures for 11th Grade Males and Females (Subsample 0)

TALENT Code	Description	R102	R103	R104	R105	R106	R107	R108	R110	R111	R112	R113	R114	R115	R211	R212	R220
R102	Vocabulary	---	720	677	719	641	686	594	442	453	525	548	480	550	270	475	532
R103	Literature Information	718	---	669	713	602	616	527	407	394	408	458	395	497	210	441	497
R104	Music Information	650	674	---	642	538	557	465	393	354	375	407	386	501	185	416	485
R105	Social Studies Information	737	730	615	---	602	666	571	389	422	458	525	466	540	231	458	468
R106	Mathematics Information	698	635	572	651	---	661	493	357	427	387	388	343	435	244	445	427
R107	Physical Science Information	730	646	575	700	725	---	567	426	534	484	484	424	475	242	440	411
R108	Biological Science Information	623	563	483	606	516	636	---	329	353	425	501	419	378	206	381	361
R110	Aeronautics and Space Information	640	569	512	562	532	632	521	---	373	355	283	253	367	131	246	267
R111	Electricity and Electronics Info.	604	463	438	487	532	668	516	594	---	433	332	299	350	148	258	254
R112	Mechanics Information	571	403	363	448	410	513	477	479	602	---	526	450	414	188	287	313
R113	Farming Information	483	371	296	444	319	423	468	351	380	532	---	477	426	234	344	336
R114	Home Economics Information	495	429	405	453	405	459	440	383	431	445	377	---	358	161	276	316
R115	Sports Information	554	550	491	592	530	481	381	396	280	311	295	304	---	146	308	345
R211	Memory for Sentences	174	149	103	146	170	185	185	140	126	153	174	160	103	---	374	222
R212	Memory for Words	415	411	353	409	445	407	337	280	272	257	256	253	303	273	---	404
R220	Disguised Words	567	535	521	478	504	485	391	401	348	342	290	325	437	126	389	---
R231	Spelling	455	462	408	452	466	401	311	282	213	224	244	251	364	130	375	500
R232	Capitalization	438	375	341	421	382	367	323	294	278	332	307	287	329	214	306	366
R233	Punctuation	576	529	474	566	625	572	434	414	374	347	342	346	408	205	450	506
R234	English Usage	547	499	450	500	511	482	411	380	336	353	331	335	367	200	372	498
R235	Effective Expression	495	437	388	461	458	433	367	343	313	313	270	301	342	181	340	419
R240	Word Functions in Sentences	534	514	449	499	643	527	414	397	351	279	268	308	407	144	424	492
R250	Reading Comprehension	758	697	605	726	665	678	588	584	491	471	434	442	547	221	437	608
R260	Creativity	608	531	490	525	523	569	492	518	520	488	413	412	409	206	348	517
R270	Mechanical Reasoning	538	386	334	422	491	557	466	496	572	548	418	360	269	199	307	406
R281	Visualization in 2 Dimensions	313	230	213	242	320	312	253	246	297	286	207	203	214	143	198	319
R282	Visualization in 3 Dimensions	425	322	279	352	431	448	365	386	452	405	283	318	208	144	245	298
R290	Abstract Reasoning	519	426	378	456	535	504	379	395	428	358	277	319	362	160	325	407
R311	Part I. Arithmetic Reasoning	621	519	457	581	662	603	465	446	474	443	369	379	440	206	387	440
R312	Part II. Introductory H.S. Math	631	571	498	597	832	659	466	473	469	361	297	343	482	201	436	469
R333	Part III. Advanced H.S. Math	513	470	420	472	738	552	382	416	388	273	219	286	398	139	376	397
F410	Arithmetic Computation	361	314	277	372	410	329	228	231	217	223	210	230	350	131	257	287

Table 3.4--Continued

TALENT Code	Description	R231	R232	R233	R234	R235	R240	R250	R260	R270	R281	R282	R290	R311	R312	R333	F410
R102	Vocabulary	440	403	622	520	480	579	748	583	503	315	418	514	626	596	433	376
R103	Literature Information	409	344	549	455	417	523	699	522	426	249	357	459	545	549	398	314
R104	Music Information	389	321	519	438	412	481	626	477	410	238	336	441	491	488	359	297
R105	Social Studies Information	438	381	587	473	438	558	715	502	417	256	368	472	601	574	404	384
R106	Mathematics Information	404	300	569	433	360	617	578	460	443	274	415	454	607	789	641	378
R107	Physical Science Information	348	321	547	411	376	548	613	504	478	275	423	456	568	612	472	338
R108	Biological Science Information	294	262	452	341	316	464	557	430	391	219	334	375	460	451	314	254
R110	Aeronautics and Space Information	174	170	274	242	222	291	385	341	351	193	251	258	279	316	262	146
R111	Electricity and Electronics Info.	188	190	308	248	225	329	385	360	339	185	272	256	354	388	311	203
R112	Mechanics Information	236	258	377	296	273	329	446	433	421	266	323	326	422	377	254	278
R113	Farming Information	304	308	464	339	315	407	520	431	394	246	327	342	438	400	257	317
R114	Home Economics Information	259	265	406	318	317	341	437	410	382	248	335	356	433	361	231	289
R115	Sports Information	283	266	391	321	309	367	482	419	361	255	280	347	413	421	303	282
R211	Memory for Sentences	171	231	299	233	210	245	294	234	211	177	202	229	279	240	162	173
R212	Memory for Words	376	324	487	366	319	471	496	382	334	239	310	381	438	430	309	302
R220	Disguised Words	500	336	536	478	393	483	586	473	394	316	316	459	453	411	277	346
R231	Spelling	---	363	552	459	343	454	469	325	215	170	196	307	426	424	251	401
R232	Capitalization	429	---	509	439	374	337	421	283	261	212	243	372	384	347	197	362
R233	Punctuation	550	530	---	566	499	639	646	468	444	320	406	530	615	596	385	463
R234	English Usage	470	481	595	---	450	453	523	388	329	222	290	388	463	433	297	324
R235	Effective Expression	417	413	519	509	---	415	520	381	322	216	286	398	434	378	247	305
R240	Word Functions in Sentences	456	347	633	480	423	---	631	497	447	309	429	505	602	618	432	389
R250	Reading Comprehension	492	472	616	562	554	609	---	618	521	340	465	591	647	578	370	407
R260	Creativity	345	353	474	429	416	489	651	---	503	352	442	484	527	472	353	313
R270	Mechanical Reasoning	192	303	425	362	341	406	530	552	---	463	574	521	475	456	338	258
R281	Visualization in 2 Dimensions	120	199	271	227	213	283	337	345	493	---	440	385	327	313	202	232
R282	Visualization in 3 Dimensions	157	246	376	287	285	392	434	452	626	481	---	516	452	439	320	249
R290	Abstract Reasoning	275	337	473	375	393	470	555	494	597	419	557	---	532	482	316	353
R311	Part I. Arithmetic Reasoning	401	419	597	493	473	555	638	510	515	332	444	526	---	638	446	431
R312	Part II. Introductory H.S. Math	446	405	640	497	458	638	633	503	483	331	446	547	697	---	601	456
R333	Part III. Advanced H.S. Math	362	299	510	400	362	552	491	418	400	282	379	431	554	732	---	272
F410	Arithmetic Computation	332	326	404	326	304	333	398	298	234	202	230	333	431	443	317	---

Note. Reproduced from Flanagan, Davis, Dailey, Shaycoft, Orr, Goldberg, and Neyman (1964), pages 2-34 through 2-37, based on 3,619 males and 3,557 females. The correlations for females are given above the diagonal, and the correlations for males are below the diagonal. Decimal points are omitted.

were determined, using the data from all Project TALENT respondents who were in the 11th grade in 1960.

Separate analyses were performed for males and females, and separate 8-dimensional models were accepted for both males and females on the basis of the proportion of variance accounted for in each of the 32 variables in general and in the math and science measures in particular. The 8 dimensions were then subjected to a varimax rotation in order to aid in the interpretability of the discriminant analyses in the next step. Such a rotation has no effect on the degree of discrimination in such an analysis but tends to increase the interpretability of the dimensions. Tables 3.5 and 3.6 show the communalities in each of the 32 variables and their loadings on each of the 8 rotated dimensions separately for males and females.

The dimensions that resulted from the analysis of the 11th grade males were quite similar to the dimensions resulting from the analysis of the 11th grade females. The first 4 factors were nearly identical. The primary differences were that for women electronics and aerospace information tended to be relatively unrelated to farming and mechanics information while these variables formed a single factor for men, and word skills and computational abilities formed separate dimensions for men while forming a single factor for women. It was felt that these differences, while slight, were sufficiently reliable to justify retaining separate factor structures for men and women.

Results. The specific technique used to obtain the Scientific Potential index was to run a stepwise multiple regression with establishment of a career in science as the dependent variable and the 8 ability factors as the independent variables. The purpose of the stepwise procedure was to exclude factors that did not reliably add to the prediction of the criterion. At each step an F-statistic was computed for each remaining variable, testing the hypothesis that the amount of additional variance accounted for by the variable is significantly different from zero. The process was terminated when all of the F-values were less than 1.0. Although we could have "accounted" for slightly more of the variance in the criterion variable by including all of the factors, we would then expect greater "shrinkage" during a cross-validation of the index.

Table 3.5

Communalities and Factor Loadings of the 32 Ability Tests for 1960 11th Grade Males

Variables			Factor Loadings							
			1	2	3	4	5	6	7	8
TALENT Code	Description	Communality	Math	Technical Information	English	Visual Imagery	Arithmetic Computation	Information/ Reading	Memory for Words	Memory for Sentences
R102	Vocabulary	.79	.32	.44	.30	.21	.09	.59	.04	.03
R103	Literature Information	.75	.28	.25	.25	.09	.06	.72	.12	.04
R104	Music Information	.68	.21	.17	.24	.10	.01	.73	.07	-.00
R105	Social Studies Information	.75	.31	.36	.26	.08	.20	.63	.07	.04
R106	Mathematics Information	.84	.71	.21	.23	.20	.14	.42	.08	.03
R107	Physical Science Information	.76	.49	.44	.20	.21	.00	.49	-.01	.07
R108	Biological Science Information	.60	.25	.54	.15	.12	-.04	.44	.08	.11
R110	Aeronautics and Space Information	.66	.29	.40	.14	.20	-.12	.55	-.19	.08
R111	Electricity and Electronics Info.	.71	.35	.59	.10	.28	-.14	.29	-.20	.03
R112	Mechanics Information	.70	.08	.75	.17	.26	.05	.17	-.01	.00
R113	Farming Information	.75	.00	.76	.14	.10	.19	.10	.32	.01
R114	Home Economics Information	.44	.11	.53	.16	.10	.10	.30	.03	.08
R115	Sports Information	.70	.17	.09	.10	.10	.44	.66	-.14	.00
R211	Memory for Sentences	.94	.05	.08	.13	.09	.04	.04	.09	.94
R212	Memory for Words	.69	.35	.16	.20	.10	-.02	.19	.62	.28
R220	Disguised Words	.70	.10	.07	.42	.33	-.03	.51	.36	-.08
R231	Spelling	.63	.22	.06	.59	-.04	.10	.28	.36	-.07
R232	Capitalization	.63	.08	.23	.70	.09	.23	.11	-.02	.13
R233	Punctuation	.72	.45	.18	.60	.17	.12	.21	.19	.03
R234	English Usage	.63	.22	.20	.67	.12	.03	.26	.11	.01
R235	Effective Expression	.60	.19	.11	.67	.17	.03	.26	-.07	.13
R240	Word Functions in Sentences	.66	.55	.07	.36	.25	.03	.27	.29	-.04
R250	Reading Comprehension	.77	.28	.28	.41	.29	.12	.57	.11	.08
R260	Creativity	.59	.18	.35	.26	.42	.00	.43	.09	.08
R270	Mechanical Reasoning	.75	.26	.45	.15	.66	-.05	.13	-.01	.07
R281	Visualization in 2 Dimensions	.69	.04	.06	.02	.79	.13	.12	.15	.04
R282	Visualization in 3 Dimensions	.68	.29	.28	.11	.70	-.00	.06	-.05	.03
R290	Abstract Reasoning	.64	.32	.14	.24	.61	.15	.23	-.03	.05
R311	Part I. Arithmetic Reasoning	.67	.52	.29	.34	.27	.26	.23	.02	.07
R312	Part II. Introductory H.S. Math	.84	.74	.15	.27	.24	.20	.29	.08	.07
R333	Part III. Advanced H.S. Math	.74	.78	.09	.14	.18	.08	.23	.10	.02
F410	Arithmetic Computation	.76	.25	.10	.25	.13	.77	.13	-.01	.04

Note. All loadings greater than .55 have been underlined.

Table 3.6

Communalities and Factor Loadings of the 32 Ability Tests for 1960 11th Grade Females

Variables			Factor Loadings							
			1	2	3	4	5	6	7	8
TALENT Code	Description	Communality	Math	Applied Information	English	Visual Imagery	Spelling/ Computation	Technical Information	Information/ Reading	Memory
R102	Vocabulary	.78	.32	.38	.26	.20	.11	.28	.57	.11
R103	Literature Information	.73	.31	.25	.19	.13	.07	.24	.67	.06
R104	Music Information	.67	.23	.19	.20	.14	.07	.26	.67	.02
R105	Social Studies Information	.73	.34	.40	.23	.09	.13	.21	.57	.08
R106	Mathematics Information	.81	.75	.16	.12	.17	.15	.20	.33	.11
R107	Physical Science Information	.70	.49	.36	.15	.17	.04	.34	.37	.12
R108	Biological Science Information	.61	.28	.53	.06	.11	-.04	.07	.46	.15
R110	Aeronautics and Space Information	.67	.10	.04	.08	.17	-.02	.74	.29	.05
R111	Electricity and Electronics Info.	.61	.32	.28	.10	.08	.02	.64	.07	.07
R112	Mechanics Information	.66	.10	.63	.09	.21	.15	.41	.09	.08
R113	Farming Information	.67	.11	.71	.11	.14	.16	.12	.24	.15
R114	Home Economics Information	.61	.10	.69	.19	.22	.08	.05	.18	-.02
R115	Sports Information	.51	.15	.32	.08	.14	.18	.42	.39	-.04
R211	Memory for Sentences	.85	.08	.10	.16	.11	.01	.07	.03	.89
R212	Memory for Words	.62	.23	.12	.09	.15	.22	.06	.39	.56
R220	Disguised Words	.67	.04	.03	.18	.31	.43	.11	.52	.12
R231	Spelling	.69	.16	.06	.22	.01	.66	.01	.42	.10
R232	Capitalization	.68	.08	.15	.73	.10	.27	.13	.03	.15
R233	Punctuation	.71	.34	.23	.45	.23	.31	.03	.37	.18
R234	English Usage	.58	.17	.08	.57	.12	.24	.12	.35	.11
R235	Effective Expression	.63	.13	.14	.68	.17	-.01	.04	.32	.04
R240	Word Functions in Sentences	.64	.48	.16	.20	.29	.23	-.01	.42	.16
R250	Reading Comprehension	.77	.25	.30	.31	.31	.15	.13	.60	.15
R260	Creativity	.55	.18	.29	.12	.44	.11	.18	.42	.10
R270	Mechanical Reasoning	.68	.21	.24	.13	.68	-.02	.21	.20	.07
R281	Visualization in 2 Dimensions	.66	.02	.06	.00	.75	.24	.15	.04	.08
R282	Visualization in 3 Dimensions	.67	.29	.19	.15	.71	-.06	.04	.12	.07
R290	Abstract Reasoning	.62	.24	.16	.33	.57	.07	-.01	.32	.07
R311	Part I. Arithmetic Reasoning	.65	.47	.32	.28	.30	.20	.28	.31	.13
R312	Part II. Introductory H.S. Math	.79	.73	.19	.18	.23	.25	.13	.24	.09
R333	Part III. Advanced H.S. Math	.69	.79	.03	.06	.14	.07	.17	.11	.04
F410	Arithmetic Computation	.67	.28	.26	.23	.14	.67	.04	-.01	.02

Note. All loadings greater than .55 have been underlined.

Table 3.7 shows the beta weights and multiple correlations for predicting entry into a science career using the 8 ability dimensions for each of the 4 populations (all 11th graders and only those with science career plans, separately for each sex). In all cases the math dimension receives the largest weight. For both sets of males the same 6 factors were selected and assigned almost exactly the same degree of importance, the only difference being the Memory for Words dimension, which was less important in the general population than for those planning science careers. Indeed these two composites correlate .94 with each other in the population of 1960 11th grade males.

The multiple correlations with the criterion of about .3 for males are unexpectedly high, since establishment of a science career is dependent on a large number of experiential influences not directly related to high school abilities. Rever (1973), in summarizing previous research efforts relating high school variables to college majors and career development, has stated that:

> "Multiple correlation coefficients between [career] path membership and response variables range between .3 and .5. Comparable validity measures are observed by simply asking students what path they will be on in the future. So even the most sophisticated measurement techniques do not add much to what subjects themselves can predict, assuming they make a prediction." (p. 144)

Analyses of the nonability measures are described in Appendix C. When these variables are added to the ability measures, the multiple correlations rise to .54 for men and .41 for women, considerably higher than the corresponding correlations of .33 and .23 between career expectations and career outcomes for the TALENT 11th graders. In this context, the correlations for the ability measures alone are remarkably high, particularly since the criterion variable follows the independent variables by 12 years, not the 1 to 5 years that is typical in similar studies.

The functions based on the subsamples of those who had science career plans accounted for <u>more</u> of the variance of the criterion variable in those subsamples than the functions based on all 11th graders accounted for in the whole samples of 11th graders. For males, the increase in predictive

Table 3.7

Beta Weights for Predicting Science Career Entry from the Ability Factors in Several Populations

Factor	Male Populations: All	With Science Career Plans	With Science Career Plans[a]	Factor	Female Populations: All	With Science Career Plans	With Science Career Plans[a]
1. Math	.234	.203	.112	1. Math	.103	.184	.319
6. Information/Reading	.119	.152	.143	6. Technical Information	.070	.111	.092
4. Visual Imagery	.083	.125	.102	4. Visual Imagery	b	.087	b
7. Memory for Words	.033	.061	b	8. Memory	b	.074	.137
3. English	.057	.059	.075	7. Information/Reading	.055	b	.070
2. Technical Information	.050	.057	b	5. Spelling/Computation	-.029	b	b
Multiple correlations (point biserial)							
With selected factors	.286	.308	.238		.138	.260	.380
With all 8 factors	.286	.310	.248		.142	.265	.385
Percent in science careers	5.9	12.7	11.9		0.9	2.4	11.9

[a]The data were reweighted for these analyses so that each occupation makes the same contribution for males and females.

[b]These factors (and also those not listed) did not contribute reliably to the prediction of the criterion.

power was slight: multiple correlations of .29 in the total population and .31 for those with science career plans. For females, the increase was more substantial: multiple correlations of .14 and .26 respectively. If, however, biserial correlations are used to correct for the attenuation due to the dichotomizing of the criterion variable, the picture is somewhat different. For males, the prediction is better in the general population (.57 compared to .49 for those with science career plans), while for females the prediction level remains higher in the population of those with science career plans (.53 in the general population compared to .67 for those with science career plans). These results support the hypothesis that there are more nonability influences on scientific career development among the general population of women than among women with science career plans (and hence ability alone would account for a smaller proportion of the variance).

The results for females differ somewhat from those for males and the results for the two populations of females also differ somewhat. The role of information/reading and English skills was much greater for men than for women. Technical information was a more significant indicator of scientific potential for women than for men, especially for women with science career plans. Despite the differences in the regression weights, the function derived from women with science career plans correlated .73 with the function derived from all women. These two functions correlated between .74 and .89 with the equivalent functions derived from the two male samples.

One possible reason for the differences observed between the indices developed on the male and female samples is that the criterion measure is measuring the establishment of somewhat different types of careers for the two groups. More than 10% of the males classified as scientists were engineers with an advanced degree, but there were no women in this category. On the other hand, more than 20% of the women classified as being in science careers were high school teachers with no advanced degree compared to only 5% of the men.

In the previous analyses each occupation and education category contributed to the results in proportion to the sum of the weights of the people in the category. These proportions, shown in Table 3.8, differed markedly for men and women who had science career plans in high school. A third

Table 3.8

Relative Contribution of Occupation and Education Categories Classified as Science for Men and Women with Science Career Plans in High School

		Relative Weights										Mean Scientific Potential[a]			
		Graduate Degree					Bachelor's Degree Only					Graduate Degree		Bachelor's Degree Only	
		Males		Females		M & F Combined	Males		Females		M & F Combined				
Description	TALENT Job Code	Wtd. N	%	Wtd. N	%	%	Wtd. N	%	Wtd. N	%	%	M	F	M	F
Researchers															
Research (NEC)[b]	150			12	0.3				20	0.5		—	86.3		81.1
Mathematician	211	137	0.4				62	0.2	35	0.8	1.8	68.3		65.4	69.8
Chemist	231	306	0.9				1402	4.3	21	0.5	2.4	67.6		64.5	60.7
Physicist	232	280	0.9	21	0.5	2.7	77	0.2				68.6	72.7	73.4	
Geologist	234	94	0.3				68	0.2				72.0		62.8	
Scientist or physical scientist: NEC	230	60	0.2									62.5			
Biologist/Zoologist/Botanist	310	635	1.9	13	0.3	1.6	26	0.1				61.9	80.6	51.1	
Specialist in Fish, Wildlife, etc.	314	1086	3.3	21	0.5	1.8						64.7	55.1		
Pharmacologist	315								22	0.5					76.3
Microbiologist	316	40	0.1	85	1.9	1.5	44	0.1	23	0.5	1.0	66.7	73.8	65.3	75.1
Biochemist	317	53	0.2	21	0.5	1.2			21	0.5		69.7	74.1		82.6
Other Clinical Scientists	319	77	0.2	23	0.5	1.5						60.0	69.4		
Psychologist	360	289	0.9	44	1.0	4.9	49	0.1	20	0.5	1.2	60.5	66.6	63.9	73.3
Economist	382	37	0.1									71.1			
Social Scientist (misc.)	389	80	0.2	638	14.3	2.3						61.9	81.3		
Practitioners															
Civil/Hydraulic Engineer	241	745	2.3				1943	5.9				66.4		60.5	
Electrical Engineer	242	562	1.7				1931	5.9				66.0		58.4	
Mechanical/Automotive Engineer	243	774	2.4				1304	4.0				71.1		66.4	
Aeronautical Engineer	244	497	1.5				77	0.2				65.6		64.0	
Chemical Engineer	245	135	0.4				119	0.4	20	0.5	1.8	66.7		64.6	68.8
Engineer (NEC)	240	1099	3.3				1015	3.1				66.0		60.4	
Architect	250	70	0.2				1129	3.4	13	0.3	2.4	68.9		69.5	60.7
MD General Practitioner	321	716	2.2									71.6			
MD Surgeon	322	226	0.7									70.9			
MD Psychiatrist	323	127	0.4	25	0.6	3.0						68.0	69.7		
MD other and unspecified	329	4498	13.7	54	1.2	11.2						72.8	70.6		
Dentist	332	2040	6.2									62.9			
Pharmacist	335	35	0.1				1352	4.1	41	0.9	5.0	62.8		63.2	75.5
Graduate Nurse	337			75	1.7		20	0.1	1366	30.7	4.4		67.0	51.3	58.4
Physical Therapist	343						20	0.1	56	1.3	1.2			46.0	61.9
Psychiatric Social Work	371	67	0.2	77	1.7	2.8			32	0.7		55.6	56.0		60.9
Teaching H.S. Math	421	1469	4.5	42	.9	4.4	885	2.7	57	1.3	6.4	52.9	70.0	53.2	70.1
Teaching H.S. Science	422	1625	4.9	75	1.7	6.9	747	2.3	711	16.0	10.0	57.4	56.8	61.4	76.9
Teaching College Math	461	126	0.4	12	0.3	1.9						74.6	65.2		
Teaching College Science	462	606	1.8	32	0.7	5.5						69.9	68.5		
Teaching College Social Science	463	1370	4.2	54	1.2	5.2						65.1	75.6		
Efficiency Expert, Industrial Engineer	723	161	0.5				1150	3.5	21	0.5	4.0	65.9		65.6	53.4
Dietitian	871			43	1.0				608	13.7			78.2		59.1

[a]Scientific Potential was computed using the index based on males with science career plans. It is scaled to have a mean of 50 and a standard deviation of 10 in the population of all 1960 11th grade males.

[b]Not elsewhere classified.

analysis was run in which each occupation and education category was weighted in proportion to the geometric mean of the number of women and the number of men found in the category. The same proportions, shown in Table 3.8, were used for both men and women. The multiple correlation for women was greatly improved by this technique (from .26 to .38) while it declined among the men (from .31 to .24). The resultant functions were actually less similar, however. A closer examination of the data reveals the reason for this decline. The pattern of relative abilities across various science careers differs widely for men and women. One example is high school science teachers. Women in this particular career have high Scientific Potential scores; men in this career score relatively lower on Scientific Potential than men in most other science careers. Table 3.8 shows the mean levels on the final Scientific Potential index for men and women in each category. Forcing this career to have the same importance in the criterion for men and women really does nothing to make the patterns of required abilities similar. If anything, it highlights differences between the patterns of abilities.

Table 3.9 shows the intercorrelations between the six Scientific Potential functions in the 1960 11th grade male and female populations.

Consideration was given to adopting separate functions for males and females. Use of a separate function for women was ultimately rejected for the following reasons:

1. The range of careers entered by women in the TALENT population was severely restricted compared to the range of careers for men. Comparisons between the high school career plans of today's youth and those of 1960 clearly indicate that the women now in high school are seeking to enter a much wider range of science careers, although there is still sex stereotyping of career plans for certain fields of science. A measure of potential based on the restricted range of careers of the women in the TALENT sample would be clearly inappropriate for women now in high school.

2. The functions derived from TALENT women were based on a very small number of women scientists. Only 183 women among the 12,000 female TALENT 11th grade 11-year follow-up respondents were classified as scientists. Only 73 of these had had science career plans in high

Table 3.9

Intercorrelations among the Various Scientific Potential Functions in the TALENT 11th Grade Male and Female Populations

Function	Intercorrelations in the Male Population						Intercorrelations in the Female Population					
	Functions Derived from the Female Samples			Functions Derived from the Male Samples			Functions Derived from the Female Samples			Functions Derived from the Male Samples		
	F-All	F-Sci	F-Sci2[a]	M-All	M-Sci	M-Sci2[a]	F-All	F-Sci	F-Sci2[a]	M-All	M-Sci	M-Sci2[a]
F-All (based on all females)	1.00	.74	.82	.89	.81	.75	1.00	.73	.81	.84	.72	.62
F-Sci (based on females with science career plans)	.74	1.00	.82	.81	.78	.65	.73	1.00	.83	.79	.74	.58
F-Sci2[a] (based on females with science career plans)	.82	.82	1.00	.84	.76	.62	.81	.83	1.00	.83	.71	.53
M-All (based on all males)	.89	.81	.84	1.00	.94	.86	.84	.79	.83	1.00	.92	.81
M-Sci (based on males with science career plans)	.81	.78	.76	.94	1.00	.92	.72	.74	.71	.92	1.00	.90
M-Sci2[a] (based on males with science career plans)	.75	.65	.62	.86	.92	1.00	.62	.58	.53	.81	.90	1.00

Note. Data are based on the 3,619 males and 3,557 females in the 1960 subsample 0 (see Flanagan, Davis, Dailey, Shaycoft, Orr, Goldberg, and Neyman, 1964).

[a]F-Sci2 and M-Sci2 were derived from the populations of those with science career plans but weighting each career so that its contribution was proportional to the geometric mean of the number of males and number of females in the career.

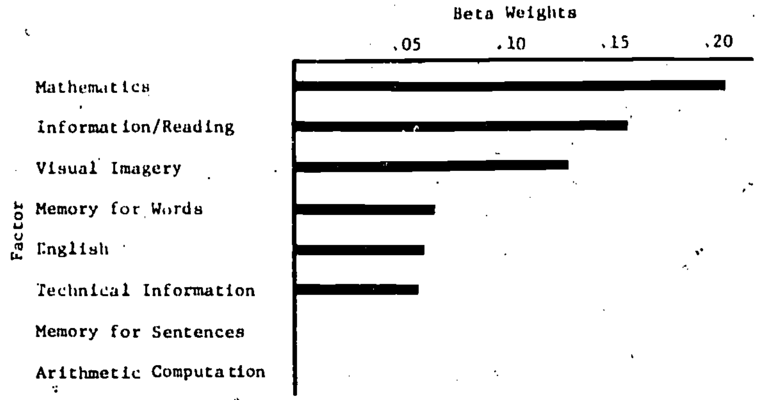
school. Because the cases are differently weighted in order to be nationally representative, the "effective sample sizes"* are much less, only 20 and 10 for these two groups.

In choosing among the three functions based on the male samples, importance was placed on moving toward an assessment of abilities required for science careers rather than merely abilities that were correlated with going into science careers. The function based on the males with science career plans was considered preferable, since correlates of science interest had to play less of a mediating role in this restricted group. For example, music information might have a correlation with science career entry in the general population only because both are correlated with having science career plans in high school.

In summary, the index of Scientific Potential was developed using 11th grade males who planned to go into science careers. For this group more than any other considered, the student's ability plays the major role in determining whether he will achieve his career plan. The largest determinant of success was math ability. How well and widely the student read and his visual imagery skills were also related to the probability of establishing a science career by age 29. Figure 3.1 shows the relative importance of each of the nearly orthogonal factors. Table 3.10 shows the index defined in terms of the original 32 tests and gives the simple correlation of the index with each test separately for males and females. Again, the math tests are the highest single correlates of the Scientific Potential index. These findings are not too surprising; the resultant function has a good deal of face validity in that these are exactly the skills that most scientists use, and other studies have also found that mechanical reasoning, spatial visualization, and math information discriminate science-oriented from nonscience students (Cooley, 1966; H. S. Astin, 1970). What is important is that the resultant function is a precise calibration of the TALENT tests for predicting successful pursuit of a science career among high school students.

---

*See the discussion of effective sample size on page 31.



Factor	Beta Weights	Simple Correlation With Criterion
Mathematics	.203	.22
Information/Reading	.152	.15
Visual Imagery	.125	.13
Memory for Words	.061	.05
English	.059	.08
Technical Information	.057	.05
Memory for Sentences		
Arithmetic Computation		

Figure 3.1. The contribution of each factor to the Scientific Potential index. (Note that the simple correlations with the criterion are based on the population of 11th grade males. Note also that the Memory for Sentences and Arithmetic Computation factors did not add reliable information to the index developed from the other factors and so were not included in the final function.)

3.2 Validation of the Scientific Potential Index

As a validation of the Scientific Potential index, an examination was made of the relationships of Scientific Potential (in high school) to measures of success as a scientist. The validation was performed on a sample of the TALENT 11th grade males who went on to become scientists. The sample consisted of 53 chemists, 20 physicists, and 40 psychologists.

Two main measures of success were used. The first was whether the respondent was included in American Men and Women of Science. (Twelve of the chemists, 2 of the physicists, and 1 of the psychologists were included.) The second criterion measure was the number of references to the respondent's publications in the Science Citation Index or in the Social Science Citation Index. In addition, prestige ratings from Roose and Anderson (1970) were entered for the respondent's undergraduate and graduate institutions.

Table 3.11 shows the correlations between these measures of success and Scientific Potential. While not all of the correlations are statistically significant within occupations, all of the ones that are significant are in the expected direction. Indeed only one correlation is not positive, and that is for the psychologist group, which undoubtedly includes both clinical and experimental psychologists and which has only one inclusion in American

Table 3.10

Definition of the Scientific Potential Index
in Terms of the Original 32 Tests

TALENT Code	Description	Standardized Weight	Correlation with the Scientific Potential Index	
			Males	Females
R102	Vocabulary	.039	.77	.76
R103	Literature Information	.069	.72	.73
R104	Music Information	.073	.66	.69
R105	Social Studies Information	.025	.71	.71
R106	Mathematics Information	.121	.86	.82
R107	Physical Science Information	.071	.78	.75
R108	Biological Science Information	.025	.60	.58
R110	Aeronautics and Space Information	.042	.63	.47
R111	Electricity and Electronics Info.	.028	.60	.48
R112	Mechanics Information	-.054	.45	.44
R113	Farming Information	-.067	.35	.45
R114	Home Economics Information	-.040	.42	.42
R115	Sports Information	.031	.56	.54
R211	Memory for Sentences	-.056	.16	.26
R212	Memory for Words	.122	.56	.60
R220	Disguised Words	.112	.67	.63
R231	Spelling	.028	.50	.48
R232	Capitalization	-.112	.36	.32
R233	Punctuation	.039	.69	.69
R234	English Usage	-.012	.55	.51
R235	Effective Expression	-.030	.50	.45
R240	Word Functions in Sentences	.144	.76	.77
R250	Reading Comprehension	.049	.78	.77
R260	Creativity	.060	.68	.66
R270	Mechanical Reasoning	.074	.66	.66
R281	Visualization in 2 Dimensions	.116	.50	.50
R282	Visualization in 3 Dimensions	.095	.60	.62
R290	Abstract Reasoning	.084	.68	.66
R311	Part I. Arithmetic Reasoning	.035	.71	.72
R312	Part II. Introductory H.S. Math	.112	.83	.79
R333	Part III. Advanced H.S. Math	.151	.75	.66
F410	Arithmetic Computation	-.086	.36	.37

<u>Men and Women of Science</u>. For the combination of all three groups, all of the correlations are significant.

While the magnitude of the correlations indicates that high school abilities as measured by Scientific Potential play only a moderate role in determining success among those who enter science careers, nevertheless this level of prediction is surprisingly high. A number of later factors, most notably those related to undergraduate and graduate education, should be expected to play a much larger role in determining a student's level of success as a scientist. Furthermore, the criteria used were rather crude, and the samples used had a very restricted range on the Scientific Potential index. All in all, these data indicate that the Scientific Potential index is a reasonable predictor of success as a scientist as well as of entry into a science career.

Table 3.11

Correlation of Scientific Potential with Measures of Occupational Success

	Criterion Groups			
Criterion Measures	Chemists N=53	Physicists N=20	Psychologists N=40	Total N=113
Undergraduate institution prestige	.18	.36	.01	.20*
Graduate institution prestige	.24	.43*	.40**	.37**
Science or Social Science Citation Index	.32**	.27	.20	.27**
American Men and Women of Science	.28*	.26	-.10	.21*

*Significance level of at least .05 (1-tailed test).
**Significance level of at least .01 (1-tailed test).

3.3 Development of a Measurement Instrument for Scientific Potential

The general index of Scientific Potential described above was based on 32 different ability and information tests that were part of Project TALENT's two-day testing program. For the present study of high school students in California, a battery requiring not much over two hours was needed. Three criteria were used in selecting the tests for this abbreviated battery. First and foremost, the tests were selected to give an index as nearly identical as possible to the general index. The second consideration was the ease of administration, particularly the time required. This precluded, for example, taking a few items from each test, since they all had separate directions to be read. Finally, in return for taking these tests, the students were to receive their own ability and interest profiles in a form that could be compared to the Career Data Book (CDB) profiles (Flanagan et al., 1973). (Figures 4.17 and 4.18 are similar profiles from Rossi et al., 1975. Figure 1.1 is an example of a student's profile produced as part of this project.) Thus one additional constraint was that the test battery had to be constructed so that the CDB scale scores could be generated with reasonable accuracy.

The specific goals were to develop an abbreviated test battery that (1) would account for at least 80% of the total variance in Scientific Potential ($r > .89$), (2) account for at least 70% of the variance in each of the 32 CDB scales ($r > .83$), and (3) require not more than 2 hours of testing time (exclusive of the time needed to distribute the tests and read the directions). Item and scale correlations from the 4% sample of the 1960 TALENT data were used to compute the required correlations for each proposed battery.

The first part of the battery was the entire Project TALENT 205-item Interest Inventory, which takes 20 minutes of testing and from which 17 of the CDB scales are derived. These interest scales were needed not only to provide the ability and interest profiles for the students, but also for the investigation of nonability factors that are related to planning a career in science. The initial version of the battery also included the introductory math test (the advanced math test had a large grade effect), the reading comprehension test, and the vocabulary, literature, math, and physical science items from the information inventory. The initial version included about 1 hour and 50 minutes of testing time.

Table 3.12 shows the multiple correlations of the missing CDB scales with the information and ability scales selected. Five of the missing scales were not adequately reproduced: Music Information, Biological Science Information, Creativity, Mechanical Reasoning, and Visualization in 3 Dimensions. Since all of Part I of the Information Test was prohibitively time-consuming (90 minutes), a small number of items from the missing information scales that had a high correlation with the total scores for these scales were added. In addition, it was necessary to include either Mechanical Reasoning or Visualization in 3 Dimensions as these scales were not adequately reproduced from the others. These two scales were highly correlated so that only one was needed. Visualization in 3 Dimensions was chosen since it had a higher loading on Scientific Potential. The contents of the final version of the battery are shown in Table 3.13.

Table 3.12 shows the multiple correlations of the missing CDB scales with the initial and revised battery. The battery had a multiple correlation of .94 with Scientific Potential, which was comfortably above the target of .89, and the testing time was 1 hour and 59 minutes. With the directions and other administrative time, the battery took just over 2-1/2 hours of class time to administer. Since the Career Planning Survey took slightly less than 2-1/2 hours, the two instruments could be scheduled into 5 hours.

3.4 Summary

An index of Scientific Potential was developed. The index was the linear combination of 32 Project TALENT ability tests that best discriminated between those males with science career plans in 11th grade who had a job in a science field 11 years after high school graduation and those who did not. The index was nearly identical to a similar index based on all TALENT 11th grade males and highly correlated with similar indices based on TALENT 11th grade females.

Table 3.12

Multiple Correlations of the Omitted CDB Scales with the Scales Selected

TALENT Code	Description	Multiple Correlation with Other Scales: Initial Version	Final Version
R104	Music Information	.809	.913
R105	Social Studies Information	.911	.913
R108	Biological Science Information	.830	.914
R230	English Total	.935	.939
R260	Creativity	.828	.836
R270	Mechanical Reasoning	.798	.842
R290	Abstract Reasoning	.850	.866
R311	Arithmetic Reasoning	.871	.871

Table 3.13

Contents of the Career Interest and Aptitude Inventory

TALENT Code	Description	No. of Items	Testing Time
Abbreviated Information Test		(120)	40 min.
R101	Screening	12	
R102	Vocabulary	21	
R103	Literature	24	
X104	Music	6	
R106	Mathematics	23	
R107	Physical Science	18	
X108	Biological Science	6	
R109	Scientific Attitude	10	
Aptitude and Abilities Tests			
R312	Introductory Mathematics	24	20 min.
R282	Visualization in 3 Dimensions	16	9 min.
R250	Reading Comprehension	48	30 min.
Interest Inventory		(205)	20 min.
P701	Physical science, engineering, math	16	
P702	Biological science and medicine	8	
P703	Public service	11	
P704	Literary-linguistic	16	
P705	Social service	12	
P706	Artistic	7	
P707	Musical	5	
P708	Sports	8	
P709	Hunting and fishing	3	
P710	Business management	14	
P711	Sales	6	
P712	Computation	10	
P713	Office work	7	
P714	Mechanical-technical	15	
P715	Skilled trades	18	
P716	Farming	7	
P717	Labor	10	

The Science Potential index was found to predict four selected measures of success within science careers in addition to holding a job in a science field.

An abbreviated 2-1/2 hour test battery was developed that yielded an index of Scientific Potential nearly identical to the general index and also reproduced the 32 CDB scales so that CDB profiles could be returned to the students tested.

66

CHAPTER 4

Career Development Toward Science Careers

4.1 Analytic Procedures

Data analyses in this project involved two distinct data bases, made use of several different criterion measures in each, and included a number of analytic techniques that were designed to complement and build upon one another. In this chapter, the results are organized around eight general research questions.

1. How are Scientific Potential, science career plans, and jobs in science fields related to sex, to ethnic differences, and to family background factors?

2. How are Scientific Potential, science career plans, and jobs in science fields related to activities, interests, and values in high school?

3. How are Scientific Potential, science career plans, and jobs in science fields related to high school courses taken and grades obtained?

4. What kinds of career guidance activities are viewed as important by high school students, and how is involvement in these activities related to Scientific Potential and having a science career plan?

5. What errors do students have in their self-perceptions and their perceptions of people in careers, and how do these errors relate to Scientific Potential and science career plans?

6. How are postsecondary education plans related to Scientific Potential and science career plans for students of different sexes, ethnic groups, and family backgrounds?

7. How are science career plans related on the one hand to Scientific Potential and on the other hand to establishing a science career, and how have science career plans of high school students changed between 1960 and 1975?

8. Which science fields and which nonscience occupations have attracted individuals with high Scientific Potential, especially women and ethnic minority members?

Before turning to these research results, we briefly describe the two data bases used, Project TALENT and the 1975 data, and the major analytic steps. Table 4.1 presents a general outline of the types of analyses performed on each data base. The results of much of this analysis are presented in greater detail in Appendices B, C, and D, as described below.

Project TALENT. Project TALENT assessed a large number of potential career development factors during the two days of intensive testing in 1960. These variables consist of 394 biographical questions covering family background, school and extracurricular activities, and educational and career plans for the future; 10 scales based on 126 self-descriptive terms dealing with aspects of the student's personality; and 17 interest inventory scales based on 205 items that assessed how interested the student was in 122 occupations and 83 activities. Derived scales of socioeconomic status (SES), study habits and attitudes, and work activities, chores, and jobs have been constructed from sets of related biographical questions. The Project TALENT data analyzed in this study were from the students who were in 11th grade in 1960.

a. Correlates of Scientific Potential. The first analyses carried out concerned the kind of student who had high science ability. This was not an investigation of the etiology of science ability; neither Project TALENT nor the current study contain data on the developmental processes that unfold prior to high school. The purpose of these analyses was to give a general picture of the concurrent characteristics of high school students with high Scientific Potential and to provide the background required for a fuller understanding of the relationships explored in later analyses.

Because of the high expense of calculating large numbers of correlation coefficients (around 400 variables) in large samples of subjects (approximately 12,000 each for males and females), we drew a smaller subsample of males and females from the Project TALENT master files. These samples consisted of all the individuals with jobs in science fields in 1972 and a random 30% of the individuals in nonscience careers. The nonscience individuals still outnumbered the science individuals more than 3 to 1 for males, and 27 to 1 for females. Correlations, partial correlations, and regression functions were determined using these subsamples. Since the ratio of nonscience

Table 4.1

Data Bases, Criterion Variables, Analytic Techniques, and Subpopulations Involved in the Various Analyses of This Project

Data Base	Subpopulations	Criterion Variables	Analytic Techniques
Project TALENT: variables assessed in 1960 and 11-year follow-up variables assessed in 1972	Science career plans vs. nonscience career plans Science occupations vs. nonscience occupations Females vs. males Blacks vs. total population	Scientific Potential Science vs. nonscience career plans in high school Science vs. nonscience occupation 11 years after high school graduation	Correlations Partial correlations controlling for Scientific Potential Linear regressions Crosstabulations of frequencies and means
Science Career Development: variables assessed in 1975	Science career plans vs. nonscience career plans Females vs. males Blacks, Orientals, Spanish surname students, and other whites	Scientific Potential Science vs. nonscience career plans in high school	Crosstabulations of frequencies and means

to science cases was considerably smaller than in the general population, correlation coefficients were not as attenuated by the skewness of the criterion variable as they might otherwise have been. (In analyses of dichotomous measures such as science vs. nonscience occupation, we have reported point biserial correlations rather than biserial correlations unless otherwise indicated.)

b. Partial correlations controlling for Scientific Potential. In order to investigate which nonability measures were indicative of a person's pursuing a career in science when Scientific Potential is controlled, we determined the partial correlations of the Project TALENT variables listed above with being in a science occupation 11 years after graduating from high school, partialing out Scientific Potential. The resulting partial correlation coefficients indicate the extent to which each of the variables is related to entering a science career when abilities typical of scientists are held constant. This procedure was repeated separately for both sexes, using the same 11th grade participants from whom the index of Scientific Potential had been developed. Appendix B displays the correlations of some of the more important variables with Scientific Potential, with science career plans in high school, and with later science occupations, as well as the partial correlations of these variables with science occupations controlling for Scientific Potential.

c. Linear regressions. It is impossible to estimate from the individual correlations of a set of variables with a criterion, such as having a science career plan, how much of the total criterion variance is accounted for by the whole set of variables. Two variables might make separate contributions to the explanation of who goes into science, such that the two together have much more explanatory power than either alone; on the other hand, two variables might be accounting for a common portion of the variance, such that either alone would have almost as much explanatory power as both together. In order to estimate the predictability of criterion measures within different groups, and in order to discern which variables contributed unique components of predictability to the criterion variance, we regressed both career plans in high school and occupation 11 years after high school on a selected subset of the variables used in the partial correlation analyses. The selected variables consisted primarily of the items or scales with the largest correlations with having a science occupation after partialing out Scientific Potential. If an item had a significant partial correlation for at least one sex it was selected, except that an effort was made to choose only one representative variable when several were similar and highly intercorrelated. To these variables were added several others that did not have large partial correlations with science occupations, but are of theoretical importance, such as the number of science courses taken, SES, whether the student's father had a science occupation, whether the student's mother was a professional, and the amount of father's and mother's education. Altogether, 37 variables were used in addition to Scientific Potential. The results of these regression analyses are discussed in some detail in Appendix C.

The results in Chapter 4 are organized by content area, as described earlier in this section. In contrast, the linear regressions included variables from several content areas, and thus for the sake of clarity they are described separately in Appendix C, with particular findings of the regression runs summarized where appropriate in this chapter. We do suggest, however, that readers interested in viewing the TALENT data from a multivariate perspective turn to Appendixes B and C after finishing Chapter 4.

d. Distributions of Scientific Potential scores. In order to provide the basis for crucial comparisons, the frequency distributions of Scientific Potential scores were computed for different subpopulations, and the mean levels were computed for many groups of individuals, such as those in a particular occupation.

1975 data. Analyses of the ability and nonability measures collected by this project primarily consisted of computation of frequencies of all the responses, distributions of Scientific Potential for various subpopulations, crosstabulations of responses, and the relationships between Scientific Potential and science career plans for subjects selecting each response to each question. The complete results of this analysis are presented in Appendix D along with a copy of the Career Development Survey instrument: for each response to most questions, there is presented (a) the number of individuals who selected that response, (b) the percentage of that number who had science career plans, (c) the mean Scientific Potential of those who selected that response and had nonscience career plans, and (d) the mean Scientific Potential of those with science career plans.

In this chapter, the results from analyses of both data bases are organized into eight sections following the outline of content areas listed above. Figure 4.1 summarizes the organization of this chapter and the sources of the data discussed in each section. Since many of the results are displayed in detail in the appendixes, the following sections will highlight, contrast, and summarize these findings.

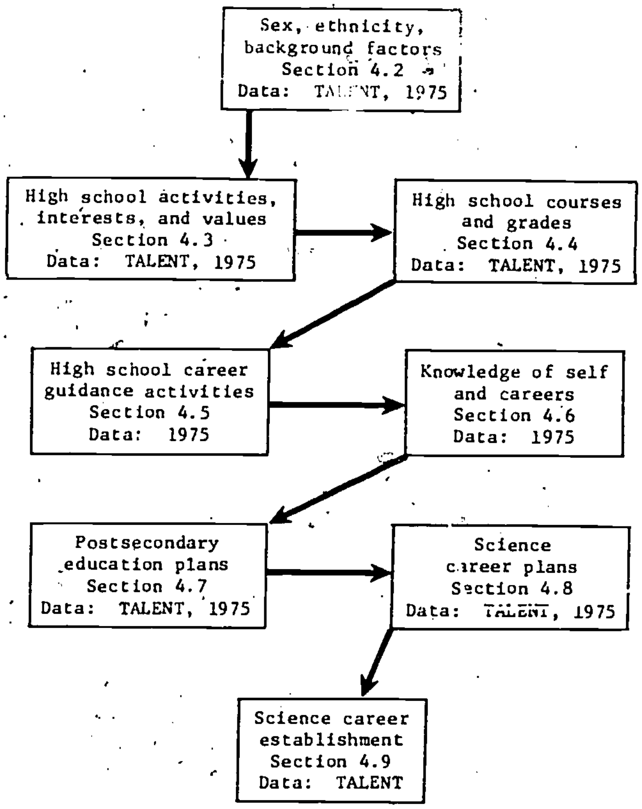


Figure 4.1. Organization of this chapter and sources of the data discussed. (Note that Project TALENT data are from the 1960 testing and from the follow-up in 1972 of the 11th grade class; the 1975 data was collected as part of the Science Career Development Project.)

4.2 Sex, Ethnic Group, and Family Background

The relationships of Scientific Potential to sex and ethnic group are of prime importance in determining why women and minorities are so grossly

72

underrepresented in the sciences. The many comparisons of men and women in science in this chapter raise the question of why the backgrounds, experiences, and plans of male and female scientists differ. Since far fewer women enter science than men, we might have expected that female scientists, as a very select group, would be even more talented relative to the rest of their sex than are male scientists. As discussed in Section 4.9, we have not found that to be true; the differences in abilities between scientists and nonscientists are about the same for men and women. A more likely reason for some of the differences between male and female scientists is that the females had to resist traditional sex role stereotypes. On the one hand they would need strong motivation based on early experiences not to follow the path of least resistance, and on the other hand the fact that they were perceived as being outside the norms for their sex might affect their personalities and values in characteristic ways. In addition, the criterion groups of scientists differ for men and women; most women in science are in the social sciences or are teaching science, while many men are in the engineering fields and physical sciences. When the criterion groups are so different in their activities and interests, we would expect that male and female high school students planning on pursuing science careers would also differ.

The Scientific Potential index was designed to have a mean of 50 and a standard deviation of 10 for the 11th grade of the 1960 TALENT data. In the 1975 sample, the mean Scientific Potential score for males (N=458) was 51.3 with a standard deviation of 12.2, and for females (N=507) was 49.0 with a standard deviation of 11.0. While the women averaged slightly lower on the Scientific Potential index than the men, the degree of overlap between these distributions is striking. In the 1960 TALENT sample there was a greater difference between men and women than in the 1975 sample, although still less than one half standard deviation (see Figure 4.16). Clearly, the paucity of women in science careers is *not* due to a failure to develop the requisite abilities prior to and during high school.

Many aspects of career development assessed in the questionnaire have been analyzed separately for eight subpopulations of students defined by four of the ethnic groups (black, Spanish surname, Oriental, and white*)

*Throughout the remainder of this report, the term "white" will be used to stand for the phrase "whites other than Spanish surname students."

and by sex. Ethnic differences in career development tended to be larger than sex differences, although there are a number of areas in which consistent sex effects appeared. Among the four ethnic groups, Spanish surname and black students often gave similar patterns of responses, different from the responses given by Orientals and whites. There were also some race by sex interaction effects, notably the tendency of Spanish surname females to have lower self-images and aspirations than Spanish surname males.

The levels of Scientific Potential in different ethnic groups in the 1975 sample are shown in Figure 4.2. Whites and Orientals had the highest mean scores; blacks, Spanish surname students, and other minority members had scores averaging more than one standard deviation below the means for whites and Orientals. By and large, blacks and Spanish surname students *have* failed to develop the abilities needed for science careers to nearly the degree their white and Oriental peers have. While some of these abilities might be developed subsequent to high school, there is a need for intervention prior to and during high school in order to reduce the apparent lack of abilities for science among these minority members. Throughout the remaining sections of this chapter, the many interactions of sex and ethnic group with other science career development factors will be discussed in sections on those other factors.

The data collected in 1960 as part of Project TALENT and the data collected in 1975 under the current study paint very similar pictures of students with high Scientific Potential. In general, these students tended to be advantaged in that they came from families with fewer children living in more expensive housing, their parents had higher levels of education, they had more books and magazines in their homes, they tended to have their own rooms, and more of them had their own desks and even their own typewriters.

A variable that represents various dimensions of advantage is socioeconomic status (SES). In the Project TALENT data, SES was based on the responses of the participants while in high school to items about: (a) value of home, (b) total family income, (c) books in home, (d) appliances, (e) presence of TV, phonograph, etc., (f) whether the participant had his or her own room, desk, and typewriter, (g) father's occupational level, (h) father's education, and (i) mother's education. A number of studies (Terman, 1954;

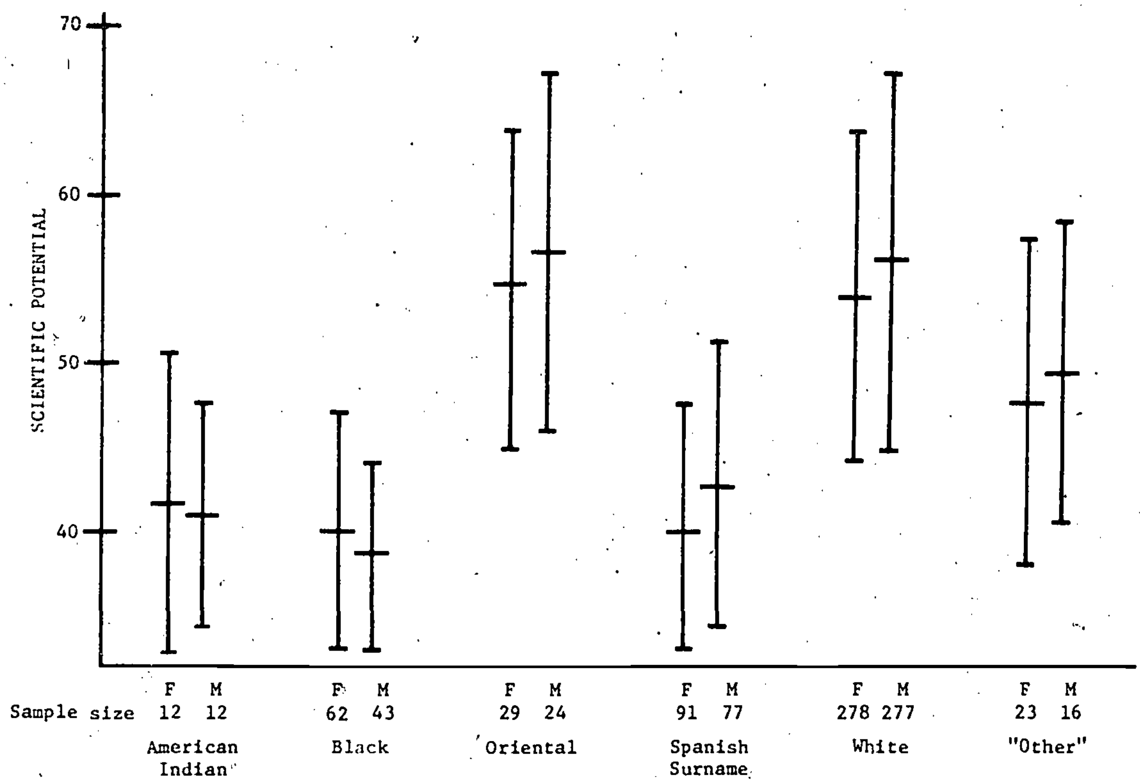


Figure 4.2. Distribution of Scientific Potential for the ethnic groups in the 1975 sample, separate by sex.

Lehmann and Nelson, 1960; Cooley, 1963; Harmon, 1965) have found that scientists tend to have come from middle and high SES families (although the effect is mainly on the level of career rather than the field), and indeed in the TALENT sample there was a correlation of .25 between SES and a later science career for men (N=2,671) and a correlation of .12 for women (N=2,743). However, we found that this relationship was greatly reduced when scientific abilities were controlled. The partial correlations between SES and a science career, controlling for Scientific Potential, were only .09 for men and .04 for women! The relation between socioeconomic status of one's family and ultimate establishment of a career in science are mediated almost entirely through abilities that have been developed by 11th grade; given equal abilities, SES bears little relation after high school. The relationship between SES and Scientific Potential is large, however, with correlations of .44 for men and .47 for women. (See Appendix B for the comparable correlations of other variables with Scientific Potential and science careers.)

The processes that relate socioeconomic advantages to Scientific Potential are not clear. Some of the effect is probably due to having more space and materials to work with as well as easy access to a wider range of information sources. Some of the effect is also due to a more academically oriented environment resulting from the parents' higher level of education. Closely related to the intellectual climate is the greater educational expectations of parents and social peers among advantaged students. Unfortunately, the economic and intellectual factors are confounded to the point that it is not possible to obtain accurate estimates of the relative contributions of each from these data. However, parents can undoubtedly influence their children's Scientific Potential by being sensitive to their children's needs for space, materials, and information sources and by maintaining strong expectations for their children's level of educational achievement. Cooley (1963) found that parental expectations had a stronger relationship to criterion group membership (prospective scientists, college nonscience, noncollege technical, or noncollege nontechnical) than did father's education, mother's education, or father's occupation. Other studies (e.g., Claudy, Gross, and Strause, 1974) have found that, even after controlling for SES, there is a clear relationship between family size and children's general academic aptitude. Over the past few years, Zajonc (1975; Tarvis, 1976) has been developing an explicit theory of why younger children in a family and large families in general tend to score lower on intelligence tests. In our analyses of the TALENT data, we found the number of siblings to be inversely related to Scientific Potential (-.24 for males [N=2,540] and -.20 for females [N=2,611]), less so to science vs. nonscience occupation 11 years after high school (-.15 and -.05, respectively), and to have a low partial correlation with science vs. nonscience occupation controlling for Scientific Potential (-.06 and -.02); these data indicate that the relation of having more siblings to not entering a science career is mediated to a great extent by lower abilities. Having fewer children may be one way in which parents are able to provide more resources and attention to those they do have. However, we cannot rule out the possibility that parents with higher abilities tend to have fewer children and also tend to pass along higher abilities to their children genetically.

Father's occupation and mother's education are background characteristics that showed strong relations to science career plans. Students with fathers in science were much more likely to plan science careers for themselves; unfortunately, there were too few students with mothers in science to determine the magnitude of that relationship. The amount of the mother's education was crucial, however, especially whether or not she attended at least a year of college: only 10% of the students whose mother did not complete high school and 17% of those whose mothers had graduated only from high school were planning a science career, while of those whose mothers had at least some college, 29% were planning to enter science. The relation of students' science vs. nonscience career plans to the amount of father's education was similar to that of mother's education, with the largest increase being between the children of high school graduates and those who had some college education, but the magnitude of the relation was smaller than for mother's education, qualifying as a <u>moderate</u> relation. Figure 4.3 displays the relationship between mother's and father's education and the science career plans of male and female high school students. Of the students whose parents did not attend college, similar proportions of the males and females had science career plans; however, males whose parents attended college were more likely to have science career plans than comparable females. It would be interesting to know the mechanisms by which even a year or two of college is translated into large changes in the career plans of the next generation. For example, is it the expanded horizons of the parents in terms of possible careers, their increased aspirations, the increased abilities of their children, or some other factor that is primarily responsible for the greater orientation of their children toward science?

Because there were large differences in mean level of parents' education between the ethnic groups, the relationship between parents' education and science career plans raises the question of whether ethnic differences in Scientific Potential and science career plans were primarily mediated by the education of the parents. Figures 4.4 and 4.5 display mean Scientific Potential as a function of ethnic group membership and mother's and father's education (for cells containing 20 or more students). As can be seen, even after controlling for parents' education there were large differences in science abilities among the ethnic groups. For example, considering only students whose fathers had graduated from high school but had not attended college, mean Scientific Potential was 49 for whites, 44 for Spanish surname students, and 40 for blacks (Figure 4.5). There is less difference between

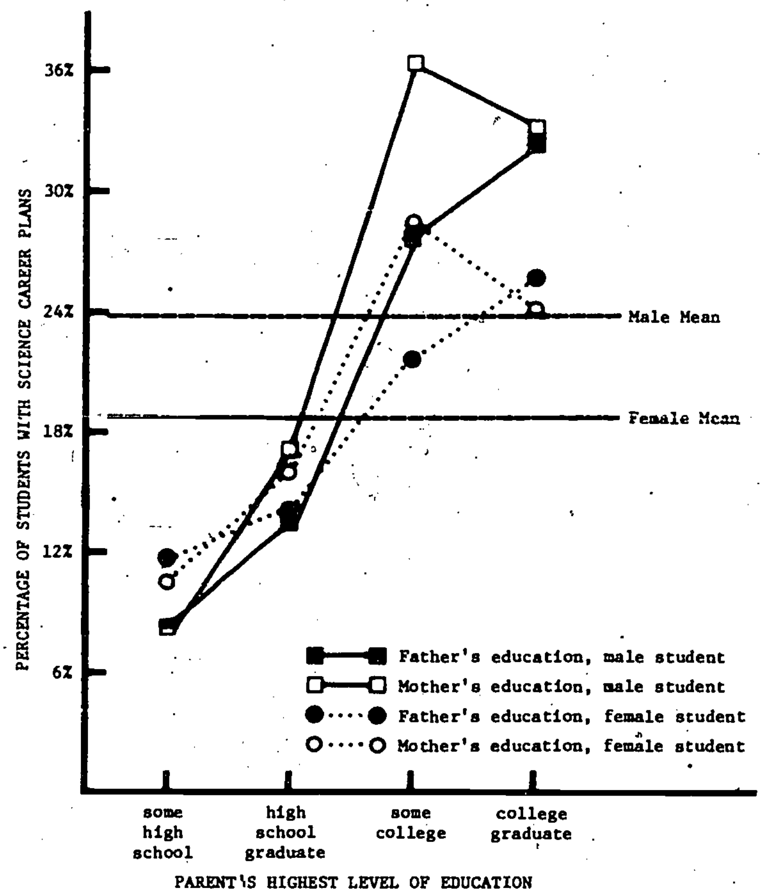


Figure 4.3. Relation between parent's educational level and science career plans of high school students in 1975.

these means than for the entire ethnic groups, but there is still almost one standard deviation between whites and blacks.

Figures 4.6 and 4.7, which display the percent of students with science career plans as a function of ethnic group membership and mother's and father's education, present a different picture. When controlling for parents' education, as high a percentage of Spanish surname students are planning science careers as of white students, while still far fewer black students have science career plans.

Some previous work has indicated that in many ways a little college education is no better than no college education. Yen and McLaughlin (1974) found that when SES and academic aptitude were controlled the salaries of college dropouts were similar to the salaries of those who never attended

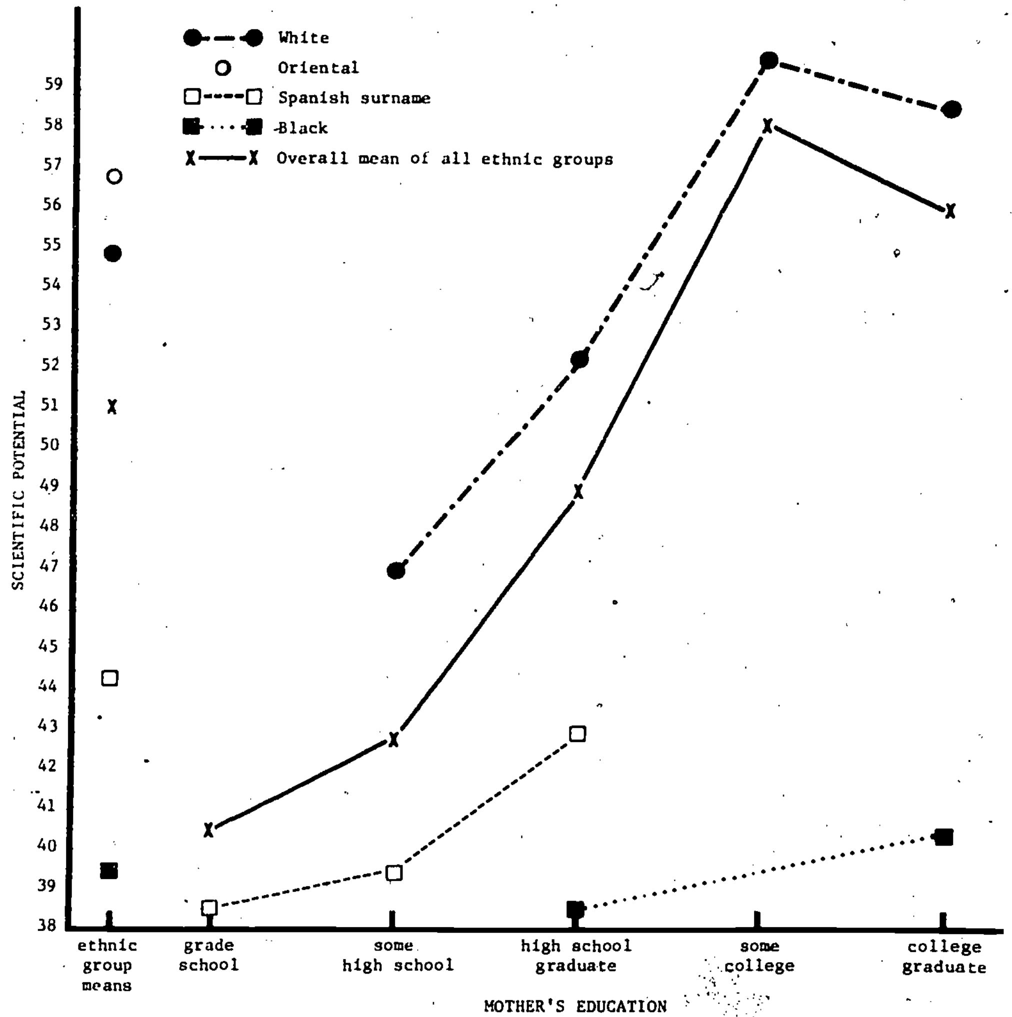


Figure 4.4. Scientific Potential as a function of ethnic group and mother's education, 1975 (only cells containing 20 or more students).

college, and that among whites job satisfaction was lower for college dropouts than for high school graduates. It would not be surprising, however, to find that in other aspects of their quality of life individuals who have completed a year or two of college are benefited by the experience; our results on the relation between parents' education and children's career plans indicate that the college experience may have as much effect on the next generation as on the present one.

Religion exhibited a strong relation to science career plans, with Catholics and atheists in our 1975 sample least likely to be interested in sci-

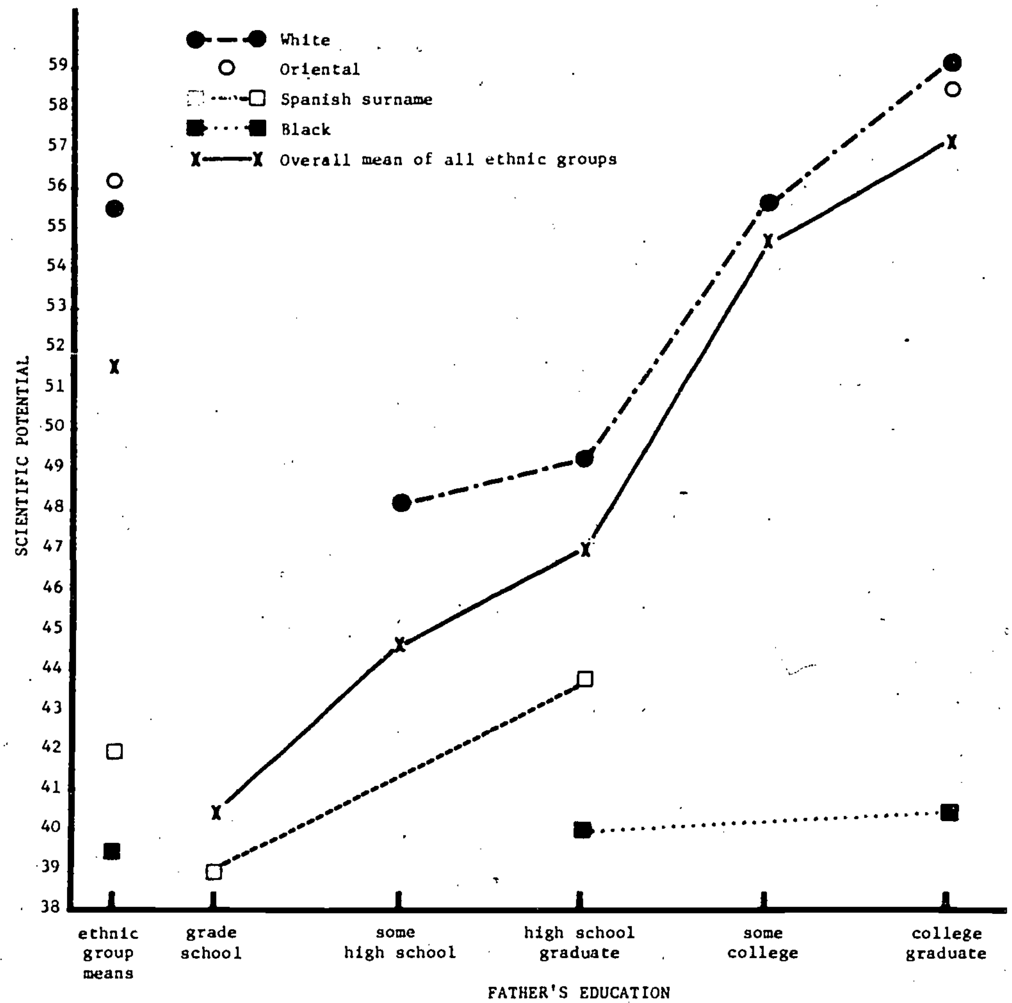


Figure 4.5. Scientific Potential as a function of ethnic group and father's education, 1975 (only cells containing 20 or more students).

ence and Jews most likely. Previous studies (Davis, 1964, 1965) have <u>not</u> found that Catholics avoid the sciences relative to Protestants and have indicated that the differences between Protestants and Catholics in terms of the scientific field chosen are not easily summarized. Religion and ethnic group membership are confounded, since Spanish surname students are almost all Catholics; since Spanish surname students were oversampled, the Catholics in our sample were not representative of Catholics in the nation as a whole.

The <u>type of community</u> in which students lived showed a <u>moderate</u> relation to the probability of science career plans. The eleven schools that participated in this project in 1975 were selected to represent inner city,

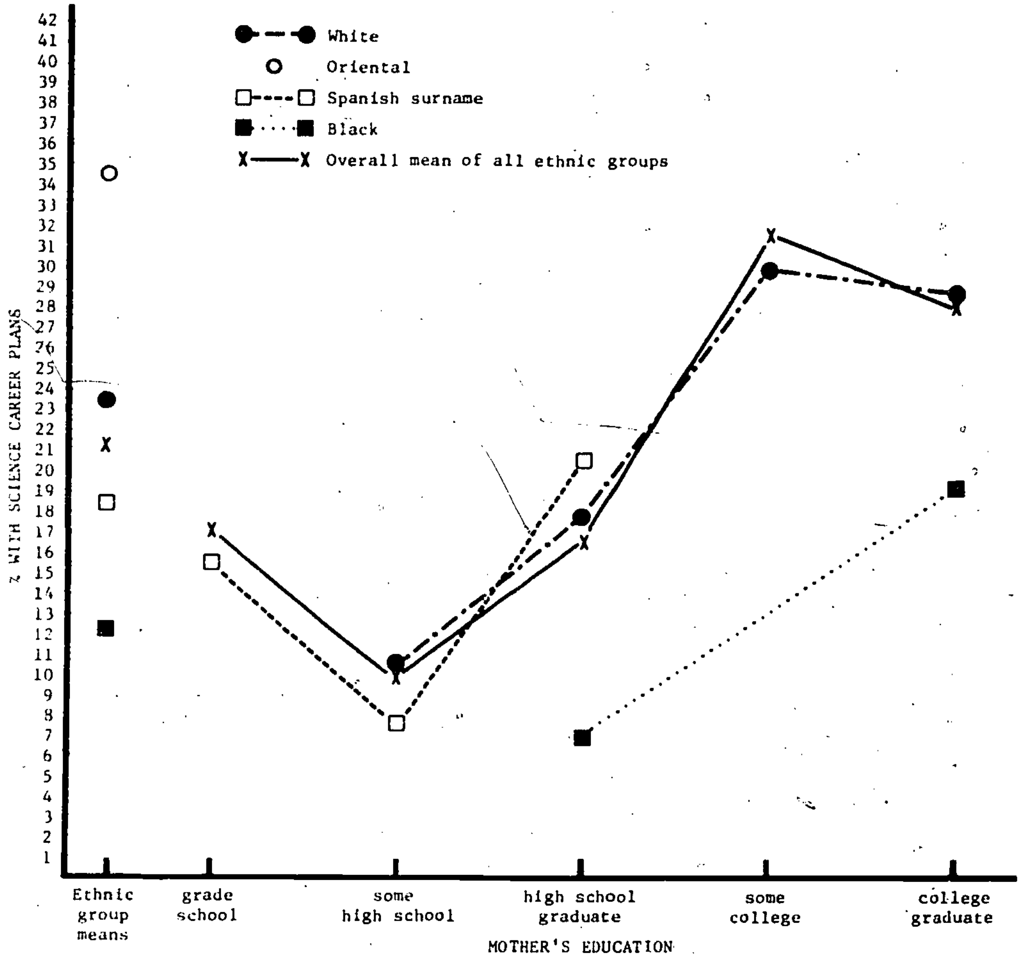


Figure 4.6. Percent science career plans as a function of ethnic group and mother's education, 1975 (only cells containing 20 or more students).

outer city, suburban, and rural communitites. (See Appendix A for details on the school selection process.) Students living in outer city or suburban communities were more than twice as likely to have science career plans as students from inner city or rural schools. Although this effect is confounded with the distribution of ethnic groups over the four kinds of communities, the difference between communities is still present when only the white students are considered; the rural communities, which had the lowest proportion of science career plans, are predominantly white.

The <u>number of siblings</u> displayed a <u>moderate</u> relation to career plans in the 1975 sample, a weak relation in the Project TALENT sample. As the number

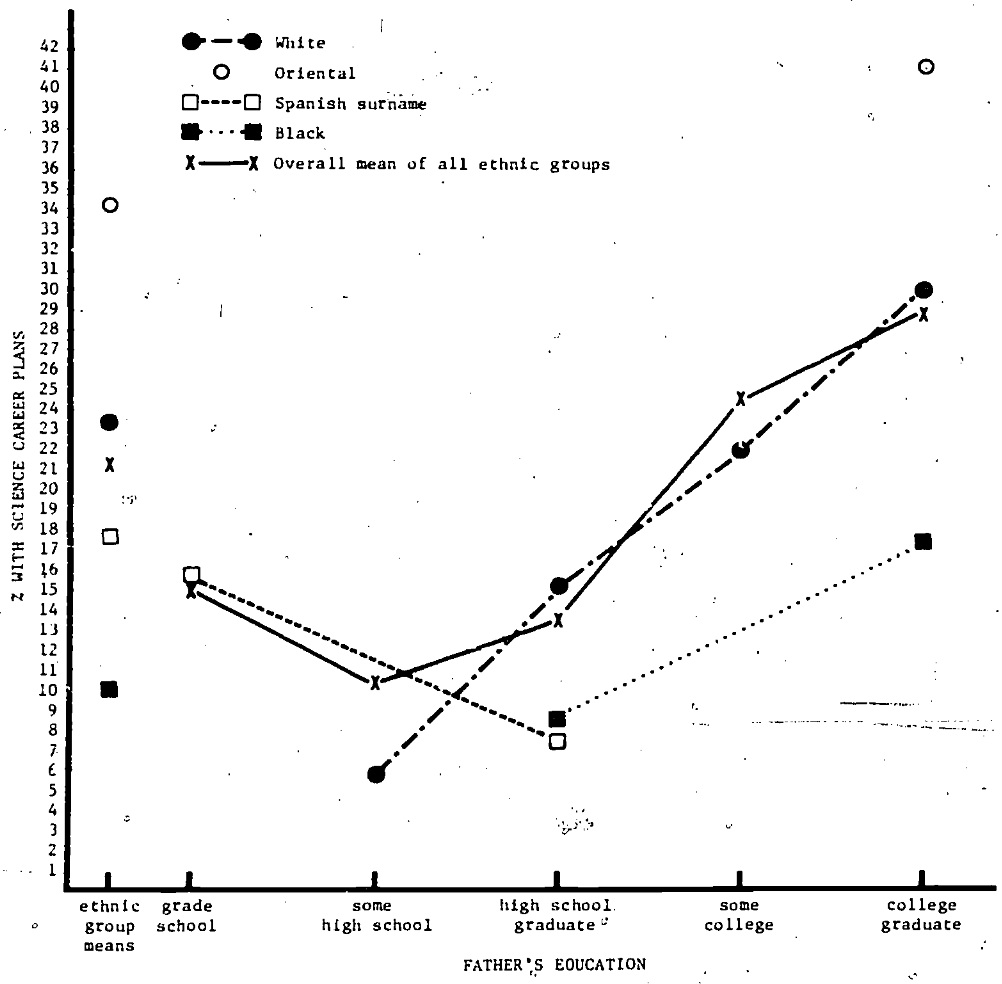


Figure 4.7. Percent science career plans as a function of ethnic group and father's education, 1975 (only cells containing 20 or more students).

of brothers and sisters increased from 0-3 to 4-7 to more than 7, the proportion planning on a science career decreased. The number of siblings was related to other variables that help account for this effect: abilities in general and Scientific Potential in particular decreased as the number of siblings increased; and blacks and Spanish surname students, who were less likely to be planning a career in science, had far more brothers and sisters than did whites and Orientals. SES has often been found to have a negative relation to the number of children in families (e.g., Claudy, Gross, and Strause, 1974).

82

4.3 Activities, Interests, and Values

At the same time that students are developing their abilities for science and are beginning to plan their careers, they are also beginning to engage in social activities, they are developing diverse special interests, and they are forming values for themselves. An understanding of the activity, interest, and value correlates of science career development will aid guidance counselors to help students choose careers that match their personalities. Counselors must be cautious, however, because the causal effects underlying observed correlations are not clear. A student with high Scientific Potential may, because of that fact, have a particular interest; or the development of high Scientific Potential may be in part the result of that interest; or both the Scientific Potential and the interest may be results of some third factor.

The results of these variables are presented here mainly to build the picture of the science-oriented students in our samples and thus to provide a background for the consideration of the effects of career guidance factors on science career development. In both the 1960 sample and the 1975 sample, students with high Scientific Potential tended to be active in intellectually oriented social activities while being somewhat less advanced in other areas of social development. Based on Project TALENT data, high Scientific Potential students were more involved in school organizations, tended to be leaders in subject-related school clubs, and attended more concerts and lectures. On the other hand, the males with high Scientific Potential tended to be less involved with cars and motorcycles and learned to drive at a later age than other males. Students of both sexes with high Scientific Potential scores had fewer dates and tended not to go steady or learn social dancing at an early age.

The social activities, hobbies, and other leisure activities of students with high Scientific Potential reflected a serious, academically oriented attitude and a minimum of "nonscientific" activities. The males in particular tended to be interested in collections (stamps, butterfly, coins, etc.) and model planes but not in metal work, wood work, or auto repair. Both males and females read more books, but far fewer love stories or movie magazines.

Some of the more important variables for predicting which females would later enter a science field were concerned with extracurricular reading. Unlike males, females who would have a science occupation 12 years later were particularly characterized by the fact that they tended to read a lot of science nonfiction, political and historical books, and biographies. They also tended to have many magazine subscriptions at home, and it does not appear to be important what the topics of the magazines were.

Turning the results from the data collected in 1975, most variables in this category displayed only weak or moderate relations to science career plans. The variable that did display a strong effect was not unexpected: the number of part-time jobs held by the student that were science related.

When students were asked to list their hobbies, the total number listed by a student showed a moderate relation to science career plans. Generally, students who listed more hobbies were more likely to be interested in science. The hobbies listed were subsequently categorized as science related or not, but there were too few science hobbies mentioned for analysis.

Other variables that displayed moderate relations to career plans were the desirability of a part-time job in high school, age at first date, and the average number of dates per week. Students who did not want a part-time job while in high school were more likely to plan on a science career. Students who first went on a date when they were 12 or younger were least likely to be interested in a science career, while students who first dated when they were 16 or older or had never had a date were most likely to be interested in science. A similar pattern was found with the average number of dates per week: those students planning on science careers tended to date the least.

Averaging over all groups, students of both sexes started dating at about the same time, with roughly half of each sex having had a date before the age of 15. However among females, Orientals were unusual with only 24% having had a date before the age of 15 and 28% having never had a date (vs. 13% over all females). Among males, whites and Orientals were late to start dating and were more likely never to have had a date. The modal age of the first date was 13 or 14 for all groups except Oriental females, for whom it was 15.

The modal number of dates per week was 1, although 1 out of 5 high school students had 3 or more dates per week. Orientals dated the least, with half never having dates; blacks dated the most, with 30% having 3 or more dates per week.

One of the major areas of the behavior of scientists that has been studied is introversion-extraversion, with scientists consistently being found to be asocial and introverts. Cooley (1963) used a number of different personality measures in a 5-year overlapping longitudinal study of the career development of potential scientists from the ages of 11 to 26. He concluded that "although these other studies have shown that scientists tend to be introverted, this longitudinal study indicates that introverts become scientists. A previous alternative explanation was that scientists simply appear introverted by the nature of their work" (p. 111). Cooley (1966) found scores on Project TALENT's Sociability scale in 9th grade to be inversely related to having science or technical career plans one year after expected date of high school graduation. This apparent introversion on the part of students who later become scientists may be a reflection of their early choice of "things" in the "people-things" dichotomy described by Cooley and Lohnes (1968) as an important determinant in science career development.

Finally, there was a moderate tendency for students who wanted to make the world a better place in which to live to be interested in science careers. On the other hand, students' responses to the question of whether they preferred to be known as a person with good, new ideas or a person who gets things done displayed little or no relation to career plans, although students who chose the first alterantive tended to have higher Scientific Potential scores.

4.4 High School Courses and Achievement

Based on the Project TALENT data, students with high Scientific Potential showed a broad range of other academic abilities. They were nearly all enrolled in college preparatory programs, had taken more foreign language courses as well as math and science courses, and routinely received good grades. They did not have trouble with reading, expressed themselves well, and they had seldom been absent from school for any reason.

Holding abilities constant, TALENT <u>males</u> who ended up in science were characterized by very good study habits and attitudes in and out of the classroom and by high grades given their abilities. These males were academically oriented, they were interested in their courses, and they could be described as overachievers. (These attributes did <u>not</u> so clearly differentiate females who entered science careers from females who did not.) Males who had a science occupation 12 years later tended to take more foreign language courses and math courses in high school than would be predicted by their abilities; they were more interested in physical science, math, and biological science than would be expected by their knowledge and skills in these areas; and they tended neither to hold part-time jobs while in high school nor to have extensive after-school chores.

TALENT females who ended up in science tended [illegible] active in academically oriented school clubs. Although like males they took more foreign language courses than would be predicted from their abilities, they did not take more math or science courses; Eiduson (1973) has indicated that scientific interests in females initially develop later than in males, during the high school or college years, thereby having less effect on the number of science and math courses taken in high school, and we have found that the Project TALENT women who did establish science careers were largely in the "softer" sciences that require less mathematical training. Females who established science careers tended to receive higher grades in science courses than would be expected on the basis of their Scientific Potential scores, but not in the rest of their courses. These females showed more interest in physical science and math than their female peers, but not more interest in biological science; biology was a field that interested most high school females, whether or not they were planning on a science career for themselves.

For students in the 1975 sample, the number of semesters of science, foreign language, and math courses taken were all <u>strongly</u> related to science career plans in the expected direction, as were the number of additional science courses planned in high school. The number of business courses taken displayed a <u>moderate</u> negative relation to science career plans. Grades in all types of courses, science and nonscience, showed strong relations to career plans.

Table 4.2 displays the percentage of students who had taken 5 or more semesters of various subjects and the mean number of additional semesters of science planned. Males had taken more science and vocational courses, while females had taken more business courses. In science, whites had taken the most courses and blacks and Spanish surname students had taken the fewest. Orientals planned to take the most science during the remainder of high school, and Spanish surname students planned to take the fewest additional science courses. Males tended to take more math courses than females; Orientals and whites took more math than blacks and Spanish surname students. Blacks had taken the fewest foreign language courses.

Table 4.2

Percentage of Students Having Taken 5 or More Semesters of Various Subjects and Mean Number of Additional Semesters of Science Planned, Based on the 1975 Sample

	Percentage of Students Having Taken 5 or More Semesters							
	Black		Oriental		Spanish Surname		White	
Subject	F	M	F	M	F	M	F	M
Science	0% (3.2)[a]	3% (1.5)	7% (2.1)	16% (3.4)	5% (1.2)	10% (1.6)	16% (2.0)	24% (2.1)
Math	28%	21%	33%	46%	21%	33%	33%	45%
Languages	4%	5%	17%	20%	10%	12%	19%	12%
Social Studies	23%	19%	24%	28%	5%	32%	41%	45%
English	45%	31%	47%	52%	42%	43%	55%	58%
Business	13%	13%	20%	8%	18%	11%	11%	5%
Vocational	6%	13%	3%	8%	6%	15%	5%	16%

[a] Numbers in parentheses are the mean number of additional semesters of science planned by all the students in each subgroup.

In Section 4.2 it was reported that black and Spanish surname students had much lower Scientific Potential scores than whites and Orientals. One could read too much into this finding and assume that the ability disparity had occurred entirely before high school and that high school science programs could have only limited beneficial effects on the underrepresented minorities. It should be remembered that the Scientific Potential index is based in part on knowledge and abilities in mathematics and the sciences. Black and Spanish surname students received lower scores partially because they chose to take fewer math and science courses; if they had become interested in science early in high school and had taken as many math and science courses as the white and Oriental students, they would certainly have received higher Scientific Potential scores than they did, regardless of their general abilities upon entering high school. In the Project TALENT data, the correlation between the number of science courses taken and Scientific Potential was .48 for males and .20 for females, and the comparable correlations for the number of math courses taken were .63 and .62 (see Table B-1).

Of the students who took various subjects, the percentages who reported grades that were mostly A's are displayed in Table 4.3. There was an overall tendency for females to report receiving higher grades, even in math and science. The sex effect was largest in foreign languages and English. Orientals reported receiving the highest grades in almost all cases. Only among white and Oriental males were science grades as high as English grades. Sex effects in the differences between science and English grades were greatest among whites and Orientals. In interpreting these results it should be remembered that the grade scale is highly dependent on the school.

Several of the schools in this study had primarily either a black or a Spanish surname enrollment. It would not have been surprising, therefore, if some modest school effect on science career plans had been evident, since ethnic group membership was moderately related to science career plans. However, the school attended displayed a strong relation to career plans, outstripping the ethnic group effect and cutting across the ethnic compositions of the schools. In three of the schools less than 12% of the participants had science career plans, while in two other schools over 33% had science career plans. The schools with the lowest science interest consisted of one predominantly white rural school and two predominantly Spanish surname inner

Table 4.3

Percentage of Students Reporting Mostly A's in Various Subjects, Based on the 1975 Sample

	Percentage of Students Reporting Mostly A's							
	Black		Oriental		Spanish Surname		White	
Subject	F	M	F	M	F	M	F	M
Science	24%	19%	52%	48%	20%	15%	30%	31%
Math	24%	21%	40%	32%	24%	20%	28%	30%
Languages	17%	14%	67%	50%	39%	28%	44%	28%
Social Studies	25%	20%	64%	46%	24%	24%	47%	38%
English	32%	23%	60%	40%	27%	20%	48%	31%
Business	33%	15%	55%	54%	28%	18%	51%	53%
Vocational	37%	23%	35%	63%	36%	26%	53%	46%
All courses	20%	14%	41%	42%	20%	18%	27%	25%

city schools; the schools with the highest science interest were both predominantly white, one in a smaller city community and one in a suburban community. The information we have concerning these schools, their student bodies, and the surrounding communities does not completely account for the size of the differences in science career plans.

4.5 Career Guidance Activities

What do students view as useful career guidance activities and what do they view as important informational goals of career guidance? This question approaches the heart of the present effort. If it turns out that students with science career plans are more aware of career planning and more exposed to career guidance, then this suggests that efforts be focused on guidance as a mechanism for facilitating science career development. It is especially important to find out whether the relations between career guidance activities and science career plans are sources of ethnic and sex imbalance in the sciences.

When the 1975 sample of students was asked how helpful each of 14 career guidance activities would be in thinking about and finding out about jobs, the activities that students with science career plans indicated would be most useful were (1) summer or after-school employment to get job experience, (2) touring plants and businesses, (3) taking tests to find out about one's abilities, interests, and personality, and (4) listening to guest speakers describe their jobs. The activities that science students noted as least useful were (1) playing classroom or computer games to find out about job interests, (2) reading about leaders in different fields, (3) talking with teachers about jobs, and (4) looking up government reports on job opportunities. Females rated most activities to be more useful than males did, especially acquiring job experience, attending career guidance classes, and group discussions. We do not know how much women's interests in career guidance activities have changed in recent years; however, it is quite possible that the high awareness of the usefulness of these activities by female high school students is partially the product of the women's liberation movement. Blacks and Spanish surname students were more interested than other students in movies about jobs, career guidance classes, group discussions, and reading books about leaders in different fields, and less interested in listening to guest speakers, touring businesses, and job experience. Figure 4.8 displays the ratings of the usefulness of the career guidance activities by students with science and with nonscience career plans. There is a close correspondence between the ratings of the two groups.

When asked what kinds of career guidance knowledge were most important, students with science career plans most frequently indicated (1) knowing how to set goals and plan for the future, (2) knowing where to get job training, and (3) knowing the requirements for different jobs. The knowledge least frequently rated as very important was how careers can be grouped and which careers are related to one another. The lack of concern for this kind of information indicates that the students were probably planning on specific occupations rather than exploring the possibilities in families of related careers in which they might be interested. Women thought that knowing about job requirements and being aware of job availability were more important than men did. Spanish surname students tended to rate the value of most career guidance knowledge lower than did other students, and in particular they thought it was less important to know how to set goals, where to get training,

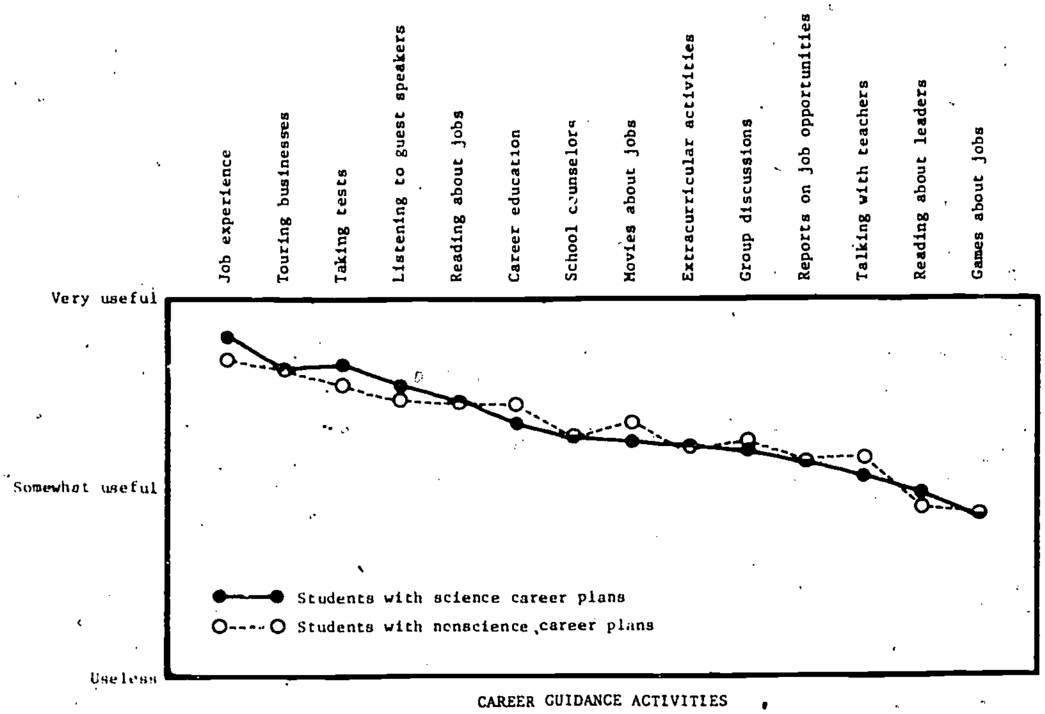


Figure 4.8. Mean ratings of the usefulness of various career guidance activities, separate for students with science and nonscience career plans, based on the 1975 data.

how to check up on the working conditions, and what abilities and interests match with what jobs. Figure 4.9 displays the importance ratings of various kinds of career guidance knowledge by students with science and with nonscience career plans. As with the usefulness of career guidance activities (Figure 4.8), there is a close correspondence between the ratings of the two groups.

Students indicated that they thought the best way to find out about a job was through talking to people, especially those on the job, and through prior job experience. When asked what career guidance source had had the most influence on them, however, 28% indicated parents or other relatives, 17% said that they had not received any help from other people, and only 13% indicated people on the job, observation of workers, or job experiences. Almost no one mentioned career guidance classes or guidance counselors in the high school.

Unfortunately, many of the activities that students thought would be useful are not well suited to conveying information about science careers.

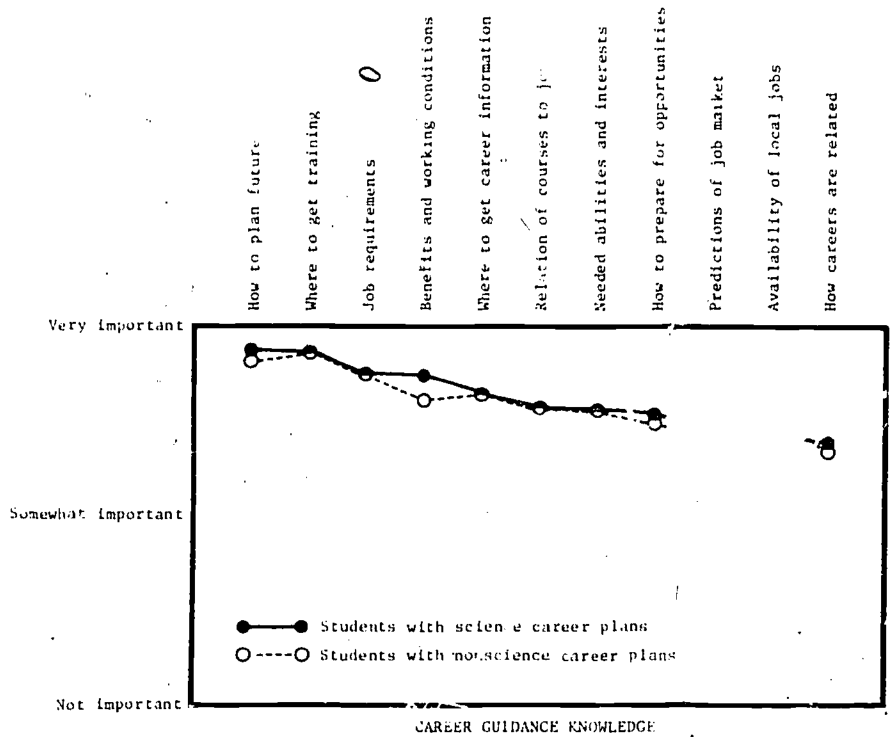


Figure 4.9. Mean ratings of the importance of various kinds of career guidance knowledge, separate for students with science and nonscience career plans, based on the 1975 data.

Summer and after-school employment, touring plants and businesses, and knowing where to get job training are less applicable to science careers than to nonscience careers, while some of the activities that were underrated are more suited to long-term career planning such as is required in science career development (for example, reading about leaders in different fields, talking with teachers and career counselors, and exploring families of related careers).

The amount of school time students reported spending in each of several career guidance activities was related to planning a science career: students who spent more time in the activity were as likely or more likely to expect to have a science occupation at age 30. Since the relation was almost always in the same direction, there was also an overall relation between career guidance and career plans when averaged over all activities: students who spent more total time in all career guidance activities combined were more likely to be interested in science. The particular activities that most strongly displayed the relationship were (1) reading about different jobs, (2) visiting jobs they were interested in, (3) talking to teachers about jobs they were interested in, (4) talking about what jobs they would like, and (5) listening to guest speakers from different jobs.

What we do not know yet is the causal relationship (if any) between career guidance activities and science career plans. Are students who are interested in science more concerned about or conscious of career planning, and therefore do they engage in more career guidance activities? Or do career guidance activities expose students to career choices that they had not previously considered, and does this in turn cause more students to plan on establishing science careers? Or is it merely the case that career guidance and science interest are both related to common sets of antecedent variables, so that they tend to be correlated but neither affects the other? It would be highly informative to have the results of a study of the effects on science career plans directly attributable to high school career guidance courses. An appropriate instrument could assess not only how students' knowledge about science careers changes while taking a career guidance course, but also which information influenced students to change their career plans toward or away from science.

4.6 Self-Perceptions and Perceptions of Careers

The development of rational career plans is dependent upon accurate knowledge of oneself and of the work world. If some groups of students are consistently misinformed about their ability levels, or if they have distorted stereotypes of scientists, these groups of students are likely to make career plans that do not make best use of their Scientific Potential. In order to investigate these possibilities, students in the 1975 sample were asked to estimate various aspects of several careers, including expected income, education needed, and the abilities, interests, and values of people in the careers. They were also asked to estimate their own ability, interest, and value profiles relative to their peers and the profiles of people in the career they expected to have. From these profiles we can infer not only the relative levels of accuracy of self-perceptions and perceptions of careers, but also differences in the stereotypes of careers as a function of sex, ethnic group membership, and whether the individual planned a career in science.

The results for income expected and education required are shown in Table 4.4 for five occupations, sales clerk, chemist, business manager, computer operator, and truck driver, as well as for the students' planned occupation. Of the occupations, the scientific occupation, "chemist," was seen as most lucrative but also requiring the highest level of education. There were larger distortions in the perceptions of other occupations than of chemists. Sales clerks' and computer operators' income and education were overestimated; business managers' and truck driver's' incomes were underestimated while their education was overestimated. Financial and educational expectations for one's own planned occupation tended to be higher than one's view of typical occupations. Although it does not appear that these students were greatly underestimating income from science or overestimating education needed for science, they do appear to have underestimated the variation of income and education over occupations. Males generally predicted higher incomes than did females. Of some importance, Orientals and whites tended to view these five occupations as being more different from each other both in salary levels and in educational requirements than did blacks and Spanish surname students. The whites and Orientals made more accurate ratings of required education; none of the ethnic groups was especially accurate in estimating expected income. Moreover, blacks tended to see less relation between education and income across occupations than did others.

Turning to the abilities and interests of individuals pursuing various careers, a similarity measure based on profile comparisons was computed and is presented in Table 4.5. The similarity measure between two estimated profiles was based on a comparison of all 15 dimensions of the profiles (see Appendix D, Questions 49 and 59-62); the similarity measure between an estimated profile and an actual profile was based on the first 9 dimensions, as these are the only dimensions for which we have tested data. The actual profiles of salespersons, computer operators, and chemists are based on the results of Project TALENT test scores published in Rossi, Bartlett, Campbell, Wise, and McLaughlin (1975). The similarity measure was defined so that a value of 0 would correspond to a complete mismatch and a value of 40 would correspond to a perfect match. A difference of 10 points was defined to reflect an average deviation of one interval on the profiles drawn in the questionnaire.

94

Table 4.4

Mean Scale Values of Expected Income and Education Required in Five Occupations and One's Expected Occupation

(a) Expected Income

Scale Value	Label
1:	<$7,000
2:	$7,000-$10,000
3:	$10,000-$15,000
4:	$15,000-$25,000
5:	>$25,000

(b) Required Education

Scale Value	Label
1:	grade school
2:	high school
3:	2-year college
4:	4-year college
5:	graduate school

Occupation	Total Population[a]	Females	Males	Blacks	Spanish Surname	Whites	Orientals
(a) Expected Income							
Sales clerk	2.0 (0.9)	1.8	2.1	2.1	2.0	2.0	1.8
Chemist	3.6 (0.8)	3.6	3.6	3.4	3.5	3.6	3.8
Business manager	3.3 (0.9)	3.2	3.4	3.0	3.1	3.4	3.2
Computer operator	3.1 (1.0)	3.0	3.3	2.8	3.0	3.2	3.1
Truck driver	2.9 (1.1)	2.8	3.0	3.1	2.9	2.9	2.8
Job-at-30	3.5 (1.1)	3.3	3.8	3.4	3.2	3.7	3.6
(b) Required Education							
Sales clerk	2.4 (0.8)	2.3	2.5	2.6	2.6	2.3	2.3
Chemist	4.4 (0.7)	4.4	4.3	4.3	4.2	4.4	4.6
Business manager	3.5 (0.8)	3.5	3.5	3.5	3.3	3.5	3.4
Computer operator	3.5 (0.8)	3.5	3.5	3.5	3.4	3.5	3.5
Truck driver	2.2 (0.9)	2.2	2.2	2.6	2.5	2.0	2.1
Job-at-30	3.8 (1.0)	3.9	3.8	3.7	3.5	4.0	4.1

[a]Standard deviations are in parentheses.

Overall, individuals most accurately estimated chemists' profiles (30.5) and least accurately estimated the salespersons' profiles (26.4). Significantly, their self-estimates most closely matched their expected occupations at age 30 (32.9). That is, students, especially whites and Orientals, believed that they did have abilities and interests like the people in the occupations they planned to have at age 30. Thus, misinformation on these dimensions, either in a student's self-estimate or in his or her estimate of various careers, could be expected to have serious implications for career planning. Those planning a science career were somewhat more accurate than others, and they clearly saw themselves as similar to chemists and different from salespersons more than others; their career plans were certainly related to their

Table 4.5

Similarities Between Estimated Profiles of Oneself, Estimated Profiles for Particular Occupations, and Actual Profiles for Those Occupations

Population	Sales(est.) vs. Self(est.)	Comp.(est.) vs. Self(est.)	Chem.(est.) vs. Self(est.)	J30(est.) vs. Self(est.)	Sales(est.) vs. Sales(act.)	Comp.(est.) vs. Comp.(act.)	Chem.(est.) vs. Chem.(act.)
	Similarity Measures for Comparisons between[a]						
Total (n ≥ 745)[b]	31.2	30.8	29.9	32.9	26.4	29.8	30.5
(standard deviation)	(4.1)	(3.7)	(4.0)	([illegible].5)	(3.9)	(3.1)	(4.2)
Planning a Science Career (n ≥ 166)	29.8	31.3	31.8	33.6	27.0	30.1	31.5
Not planning a Science Career (n ≥ 578)	31.6	30.7	29.4	32.7	26.3	29.8	30.2
(Science vs. Not Science)	(t=-5.0)[c]	(t=1.8)	(t=6.8)[c]	(t=2.9)[c]	(t=2.2)	(t=.7)	(t=3.5)[c]
Female (n ≥ 390)	31.2	30.6	29.3	32.7	26.4	29.6	30.4
Male (n ≥ 353)	31.1	31.0	[illegible].6	33.1	26.4	30.0	30.6
(Female vs. Male)	(t=.3)	(t=-1.5)	(t=-4.4)[c]	(t=-1.6)	(t=0)	(t=-1.8)	(t=-.7)
Black (n ≥ 55)	32.5	30.3	30.4	31.2	25.1	29.5	29.3
Spanish Surname (n ≥ 119)	32.1	30.7	29.4	32.1	25.3	28.4	28.2
White (n ≥ 471)	30.7	30.8	30.[illegible]	33.3	26.9	30.3	31.3
Oriental (n ≥ 39)	30.0	31.1	30.0	33.1	27.4	29.7	31.7
(Black & Spanish vs. White & Oriental)	(t=4.2)[c]	(t=-.6)	(t=-.9)	(t=-4.9)[c]	(t=-5.4)[c]	(t=-5.2)[c]	(t=-7.5)[c]

[a] Sales, sales workers; Comp., computer operators; Chem., chemists; Self, the student's own profile; J30, job expected at age 30; est., profiles estimated by the students; act., actual profiles based on TALENT data on the students' test scores.

[b] Figures for sample size are minima across the seven profile comparisons. Maxima are all no more than 5% greater than minima.

[c] Differences significant at the .01-level ($|t| \geq 2.6$).

perceptions of the match between their own profiles and the profiles of those in careers. The only noticeable difference between the sexes was that females saw themselves as somewhat less like chemists than did males. This type of difference is a possible source for continuing underrepresentation of women in the physical sciences.

The most striking result in Table 4.5 is that overall students tended to see themselves as most similar to sales personnel of the three occupations, but this was partly because they were most mistaken in their perceptions of the attributes of sales personnel. The similarity of estimated self-profiles and estimated sales profiles was especially true of students not planning science careers and of the minorities underrepresented in science (blacks and Spanish surname students). We do not know what causal relation, if any, there is between misinformation on careers and the proportion of science career plans in various groups; however, there is clearly more misinformation among the underrepresented minorities, and they do rate themselves as most similar to the nonscience careers. On the basis of these results it would seem to be reasonable to recommend that greater efforts at career guidance be expended for black and Spanish surname students, including more careful use of diagnostic tests of abilities and interests and feedback of how the student compares to the general population.

Comparisons of estimates of self-profiles with actual individual profiles show the same effects: those planning science careers tended to be more accurate than others (27.4 vs. 25.8); there were no differences between the sexes; and the underrepresented minorities were significantly less accurate than others (24.4 vs. 26.9). The ability to estimate one's own abilities and interests relative to one's peers is itself related to the general Scientific Potential index (Table 4.6, Column 1). This suggests that the inaccuracies of profile estimation may not be due merely to unavailability of test scores but also to lack of developed abilities to observe and evaluate, needed for science as well as for self-perception. Thus, the abilities involved in self-estimation may be similar to the abilities involved in the Scientific Potential function; and interventions aimed at improving the development of these abilities may increase both Scientific Potential and the ability to generate the information necessary for rational career planning. The alternative artifactual explanation, that everybody tends to estimate

Table 4.6

Mean Levels of Profile Estimation Accuracy as a Function of Scientific Potential and Science vs. Nonscience Career Plans, Based on the 1975 Sample

		Subsamples					
		High Scientific Potential			Low Scientific Potential		
Estimation of:	Correlation of Accuracy with Scientific Potential for the Entire Sample	Science Career Plans (N=95)	Nonscience Career Plans (N=166)		Science Career Plans (N=69)	Nonscience Career Plans (N=412)	
Self	.46	28.7	27.2	t=3.2*	25.6	25.2	t=0.7
Salesworkers	.31	28.4	27.7	t=1.8	25.3	25.8	t=-1.0
Computer operators	.24	30.5	30.9	t=-1.4	29.6	29.3	t=0.7
Chemists	.42	32.2	32.3	t=-0.3	30.6	29.5	t=1.8
Mean Scientific Potential scores of subsamples		65.6	63.5	t=3.4*	47.1	43.4	t=4.2*

*Differences significant at the .01-level.

him/herself as being like individuals with high Scientific Potential, is not supported because there are also positive correlations of Scientific Potential with the accuracy of estimates of the profiles of chemists, computer operators, and salesworkers.

Comparison of the various means of estimation accuracy in Table 4.6 sheds light on one of the Project's objectives: to find out whether students with career plans not matching their Scientific Potential are characterized by distorted images of careers and themselves. Among students with high Scientific Potential, those planning science careers had significantly more accurate self-estimates than those not planning science careers. Thus, it may be in the area of self-perception that increases in student knowledge have the effect of increasing science career planning. In terms of the accuracy of perceptions of people in careers, there was no significant effect between students with science and nonscience career plans.

Among students with low Scientific Potential, there was no significant relation between accuracy of estimation and planning of a science career. This refutes the hypothesis that students with low Scientific Potential may have planned on science careers because of distortions of their perceptions of their own profiles or of those of individuals in careers. In both sets of comparisons, any interpretation of the results must take into account that individuals with science career plans had significantly higher Scientific Potential scores than those with nonscience career plans (see the bottom row of Table 4.6). These results are tentative at best.

The preceding profile similarity results are based on a single summary measure for each profile-pair. It is of interest to determine which scales contribute most to the discrepancies, and in what direction. In Figure 4.10, the mean estimated profiles for three occupations and the actual profiles corresponding to some scales of the estimated profiles are presented. Computer operators were viewed as being between salesworkers and chemists on most dimensions. The dimensions of greatest variation of estimates between occupations were interest in science and knowledge in science. Chemists were rated highest on all dimensions except interest in office work, interest in helping people, and desire to work with friendly people. These students seemed to be aware of the introverted and asocial tendency of scientists.

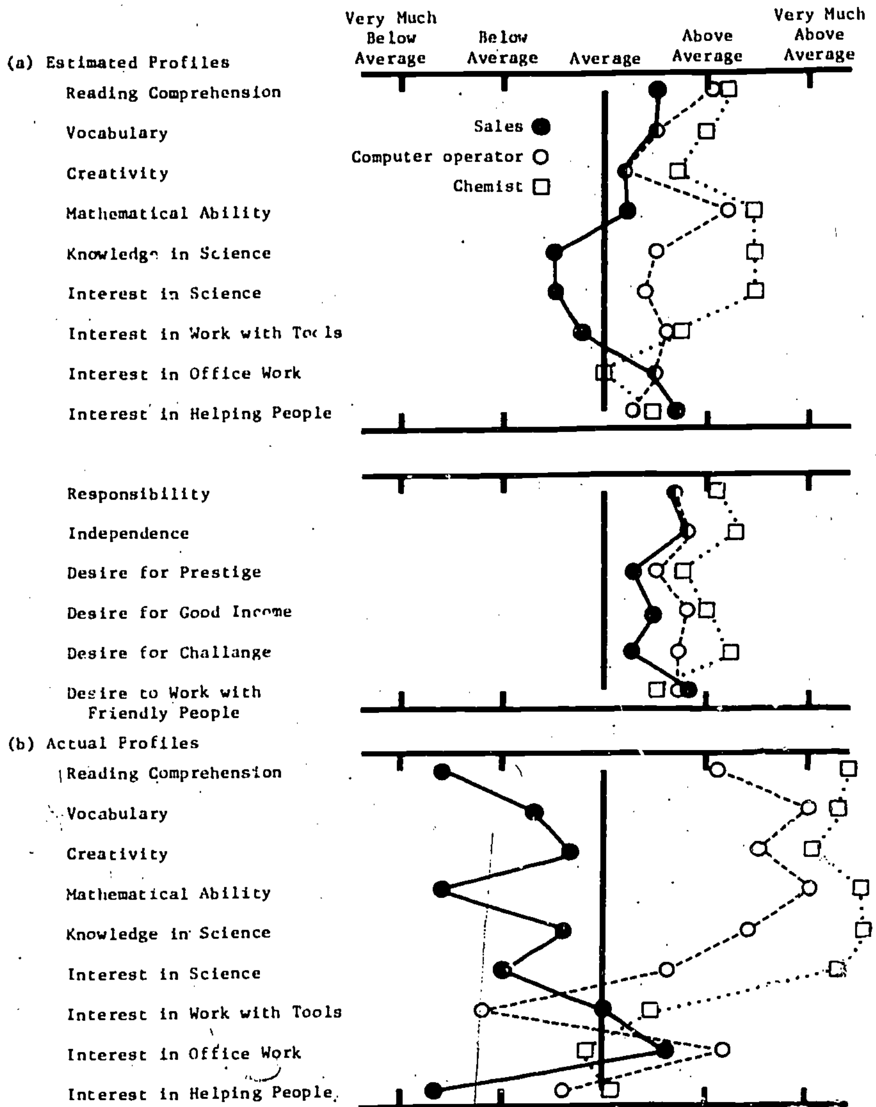


Figure 4.10. (a) Comparison of estimated profiles of three occupations, based on the 1975 sample. (b) Comparison of actual profiles based on Project TALENT.

The comparison of estimated and actual profiles shows glaring needs for more information.

Students generally tended to underestimate the abilities of chemists and to overestimate chemists' levels of interest in areas other than science. Estimated profiles of chemists by males and females were virtually identical, but there were large and consistent differences among the profiles estimated by the four ethnic groups. In particular, the underrepresented minorities

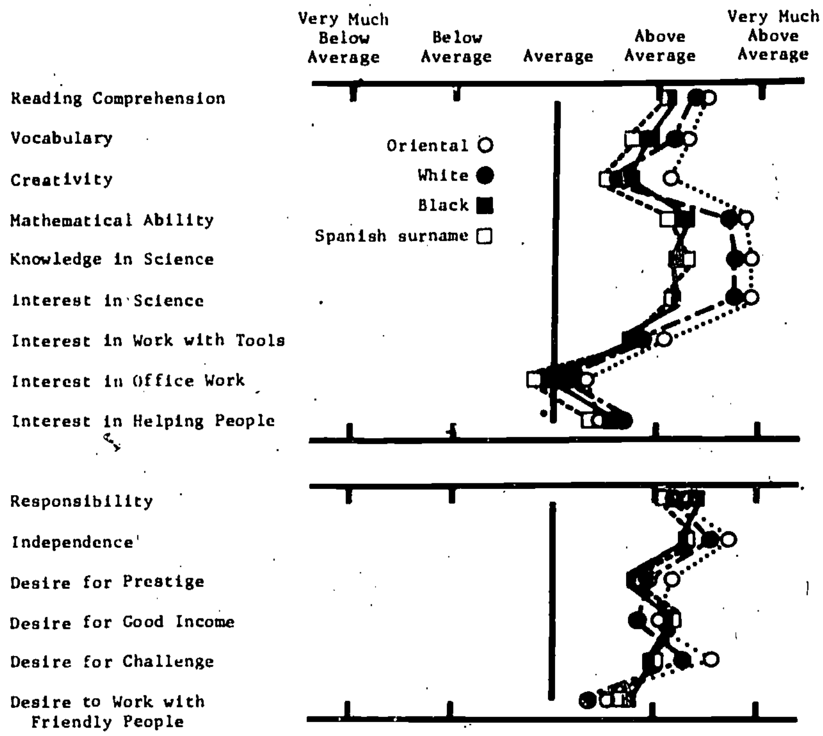


Figure 4.11. Comparison of the estimated profiles of chemists by ethnic group, based on the 1975 sample.

estimated that chemists had lower abilities than did whites and Orientals, especially ability in mathematics and knowledge of science, and blacks and Spanish surname students estimated a lower interest in science for chemists (see Figure 4.11). As a result, there were no significant differences among the ethnic groups in the similarity of their self-images to their images of chemists, but Spanish surname and black students were significantly less accurate in their estimations of chemists (see Table 4.5).

In Figure 4.12, we have presented the mean self-profile and the mean profile for jobs expected at age 30. Logically, the mean of students' estimated self-profiles should lie along the midline if estimates were veridical. We see, however, that individuals tended to see themselves as "above average" on all scales except interest in working with tools, interest in office work, interest in science, and knowledge in science. The discrepancy between the two profiles indicates the perceived need to develop one's abilities and interests in order to compete in the career of one's choice. Finally, comparison of the shape of these profiles with those in Figure 4.4 indicates

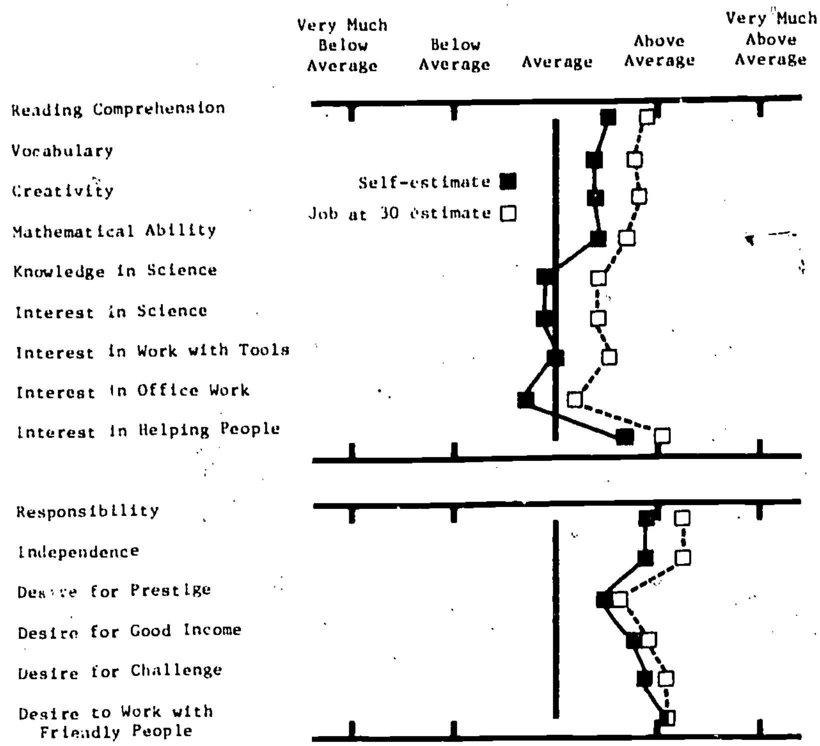


Figure 4.12. Estimates of self-profiles and estimates of profiles of persons in the occupation expected at age 30, based on the 1975 sample.

that most students saw themselves as more like their estimates of salesworkers than of chemists.

Comparison of the mean profiles of males and females (Figure 4.13) supports the summary result stated previously: males saw themselves as more similar to chemists than females did. Female students saw themselves as less interested in tools, as more interested in helping people, and as somewhat less interested in and knowledgeable about science, than male students did.

Comparison of the mean profiles for the four ethnic groups (Figure 4.14) is more complex. Whites and Orientals had very similar self-images, and their images were similar to images of chemists. Blacks and Spanish surname students were together characterized by reporting less science interest and knowledge and more interest in office work and in helping people. For this sample, it did not appear that blacks could have been avoiding science because they underestimated their overall ability levels; however, Spanish

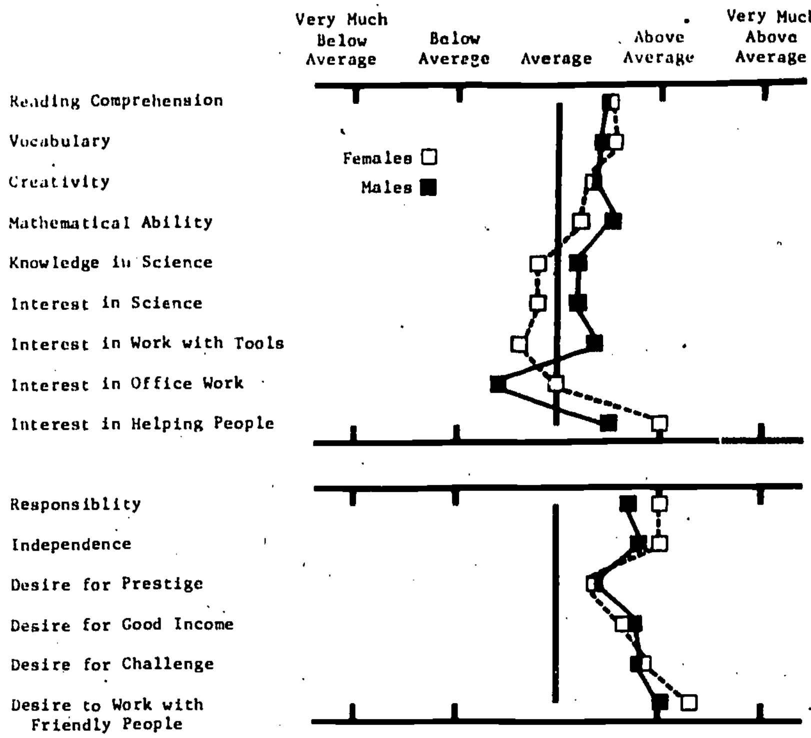


Figure 4.13. Comparison of self-estimates of females and males in the 1975 sample.

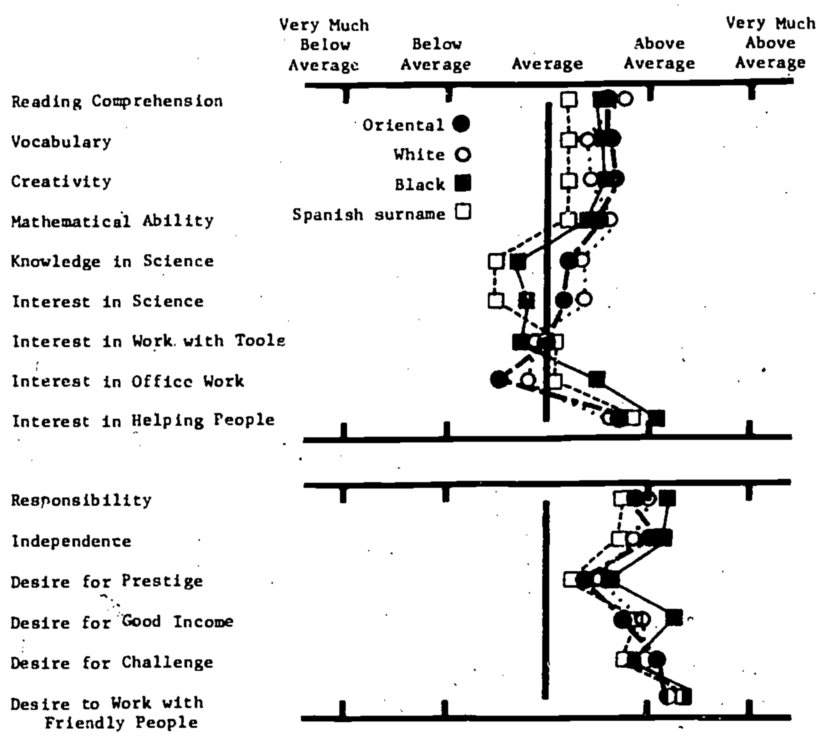


Figure 4.14. Comparison of self-estimates of four ethnic groups in the 1975 sample.

103

surname students did generally rate their abilities as lower than other ethnic groups did.

To summarize the results of this set of analyses, although students had some knowledge of themselves and careers, there were several distinct deficiencies that may be related to pursuit of careers in science. There were very few differences between the sexes; however, the underrepresented minorities were significantly less accurate than others in their estimates of their own profiles and of the profiles of people in selected occupations. These inaccuracies are certainly not conducive to healthy career development.

The career development of women is highly dependent on how men and women in our society estimate the abilities of women relative to the abilities of men, especially concerning the kinds of jobs women could perform. The high school students in the 1975 sample were asked whether women could do the same kind of work as men; 11% of the females and 25% of the males responded that not very often or never could a woman do the same kind of work as a man. These responses were most frequent among the black and Spanish surname students: 22% of the black females, 24% of the Spanish surname females, 28% of the black males, and 42% of the Spanish surname males responded "not very often" or "never." It is clearly a responsibility of our society, and especially the educational system, to inform all young people that the vast majority of jobs could be performed by either sex.

4.7 Plans for Postsecondary Education

College attendance is a crucial step on the path toward a science career. It is the step that is uppermost in the minds of high school students as they begin to look beyond their current setting. It is also the tangible outcome of the career guidance and the career knowledge that lead a student to plan for a science career. For these reasons, plans for postsecondary education were included in this study.

The Project TALENT data indicated that the educational plans of students with high Scientific Potential were much more ambitious than those of their peers. In the first place they were planning more frequently to go on to college immediately after high school, and generally to a more expensive four-year school. Their stated reason for going to college was because it was necessary for their planned career, and not because their friends were going, for the social life, or for establishing business contacts. Very few planned to go to vocational or business school or to enter a military career.

The perception of the importance of a college education by students with high Scientific Potential was demonstrated by the fact that they had been saving money primarily for college and would have been willing to borrow money in large amounts, even at high rates of interest, if it had been needed to go to college. To a certain degree, however, this may have merely reflected a different view of money by students from wealthier families. These students generally expected to pay for their education with money from parents or scholarships rather than through loans or part-time work. Females were more likely to enter a science career if they had discussed their college plans with their teachers and counselors. Females interested in science careers tended more than other females to believe girls should go to college because more trained women are needed in this country.

Overall, 94% of the students in the 1975 sample planned to graduate from high school. Only 85% of the Spanish surname students planned to graduate; however, this was largely because many of them did not know whether they would be able to graduate, not because they had already decided not to graduate. Most students indicated that they wanted to graduate from high school either because the diploma is needed for jobs (24%) or because they wanted to go to college (44%); only 33% of blacks and 35% of Spanish surname students gave the latter reason.

While only 20% of the students were planning to pursue a career that we have classified as science, 27% of the students were planning to be science majors in college and another 5% planned to learn a science trade at a vocational school. Blacks and Spanish surname students less frequently planned on having a science major in college (13% for both groups); 35% of the Orientals and whites were planning on a college science major. Whites were the least likely to consider preparing for a science career by studying science at a vocational school, while black women were the most likely to consider a science program at a vocational school (14%).

Among whites and Orientals, males were more likely than females to expect to go to a four-year college and less likely to expect to go to a community college. When the two types of colleges were combined, there was no overall sex effect: 74% of the males and 77% of the females expected to go to college. Spanish surname students were the least likely to have college plans (63%).

Students were asked what was the highest educational degree they expected to receive. The results are displayed in Table 4.7. The largest effect is that Spanish surname females were less likely to expect to earn a B.A. or higher (only 33%), and far more of them were planning to stop their education after high school (43%), than was true of any other group. On the other hand, a higher proportion (29%) of Spanish surname males were expecting a Ph.D., M.D., Ed.D., or J.D. than any other group; given their ability scores (the mean Scientific Potential for Spanish surname males was almost a standard deviation below the mean for all males), many of these expectations may not be realistic. Across ethnic groups there was a tendency for males not to consider a terminal A.A. degree as frequently as the females did.

Table 4.7

Percentage of Students Expecting to Terminate Their Education After Earning Various Degrees, Based on the 1975 Sample

	Percentage of Students Expecting This as Highest Degree							
	Black		Oriental		Spanish Surname		White	
Degree Planned	F	M	F	M	F	M	F	M
High school	12%	18%	19%	9%	43%	23%	11%	13%
A.A.	19%	11%	4%	4%	12%	5%	12%	6%
B.A.	12%	8%	26%	4%	12%	13%	13%	11%
M.A., M.S.	25%	24%	26%	35%	7%	13%	22%	26%
Ph.D., M.D., Ed.D., J.D.	23%	24%	19%	26%	14%	29%	25%	26%
B.A. or higher[a]	60%	56%	71%	65%	33%	55%	60%	63%

[a]Required by our definition of "science" in the analysis of the Project TALENT data (see Section 3.1).

Note. Percentages do not add to 100 since some students responded "other."

There were strong relationships between educational plans and science career plans. When asked why they wanted to graduate from high school, very few of the students who answered that they needed the diploma were thinking in terms of a later science occupation, while one-third of the students who mentioned college entrance requirements were planning careers in science. Similarly, few (6%) of the students who expected to attend a community college were science oriented, while one-third of the students who expected to attend a four-year college were planning to prepare for science careers.

Those interested in science careers, however, were not planning to stop their education after college. Eight percent of the students who expected that their highest degree would be a B.A. were planning on a science career, while one-quarter of those aiming for a terminal master's and half of those aiming for a Ph.D. expected to be employed in science. Similar results were found when each student was asked what the minimum required education was for the occupation he or she expected to have at age 30--two-year college, four-year college, or graduate school.

What proportion of the potential science resources of this country are lost because talented high school students decide not to attend college, and what are the characteristics of able students who decide to terminate their education early? In order to answer these questions, we selected for closer study those students who had Scientific Potential scores higher than the mean score for students of their sex with science career plans (55.7 for females and 59.0 for males). In this sample of students with abilities typical of scientists, students who were planning to attend a community college without continuing on to a 4-year college or who were not planning to attend any college were compared with the remainder.

Of the 501 females with scores on the Scientific Potential index, 157, or 31%, had scores as high as the mean of females with science career plans; of these 157 females with science abilities, 147, or 94%, were planning to attend college. In addition, 5 of the 10 who did not plan to attend a 4-year college gave conflicting responses indicating that they expected educational degrees beyond the A.A., although they were not planning to go to college; only 5 seemed definite about not trying to earn a B.A. It is informative to know that only 3%-6% of the talented females were not planning to go beyond a community college.

Of the 458 males with scores on the Scientific Potential index 34%, had scores as high as the mean of males with science career pl: these 155 males with science abilities, only four were planning not college. One of these four students gave conflicting responses ind: that he planned to earn a terminal B.A. Therefore, like the female: all of the talented males were planning to go through four years of

In the next section, the characteristics of students with high tific Potential scores who would not consider working in any science pation are examined. As might be expected, more students fall into category.

4.8 Career Plans and Expectations

In the Project TALENT data, the variable most closely related t ing a science career was the expression of a science career plan in school. Whether or not a high school student planned to enter a sci reer had a zero-order correlation of .33 with being in a science occ 12 years later for men, and a correlation of .23 for women. After p ing out Scientific Potential, the correlation was .21 for men and .2 women. There are two important findings that follow from these data the resulting partial correlations were very large relative to compa partial correlations in this study, and for women there was only a s duction of the correlation when controlling for Scientific Potential cating that career plans did not merely reflect ability. <u>Plans to w a scientific field did influence a student's chances of achieving a career independently of his or her abilities</u>.

Secondly, while the correlation between career plans and later was .33 for men and .23 for women, the correlation between Scientifi tial and later careers was .41 for men and only .18 for women. The tion of variance in science-nonscience careers of women accounted fo abilities was <u>less</u> than the proportion of variance accounted for by plans, while for men the proportion of variance in careers accounted abilities was decidedly <u>more</u> than the proportion accounted for by ca plans. <u>Abilities were more predictive of which men entered science were high school plans; however, so few women attempted a science ca</u>

that the plan to do so was more predictive of a career in science than were abilities.

The relationship between science career plans and a later science career was not strong, however, especially for females. Only 12% of the males and 6% of the females who were planning a science career while in 11th grade actually persisted in their plans; the rest were all in nonscience occupations 12 years later, if they were employed at all. Or looking at the situation from the other end, while 71% of the men in science careers had had science career plans in high school, fewer than half of the women had planned to be employed in science; most of the 29-year-old women in science in 1972 had had nonscience career plans in high school in 1960.

Tables 4.8 and 4.9 list the percentages of TALENT males and females in science occupations as a function of their career plans in high school in 1960. Career plan was assessed by a 36-option multiple choice item. The science and the nonscience career plans have been ordered according to the proportion of persons later in science careers. Males who planned to be physical scientists were most likely to persist in science, and males who planned to be sociologists or psychologists were least likely to persist in science; for females, the highest retention rate was for those planning to be mathematicians, and the lowest retention rate was for those planning to be political scientists, economists, and dentists. A male with a nonscience career plan was most likely to switch into science if he planned to be a medical or dental technician, while a female was most likely to switch into science if she planned to be a lawyer in high school. The important inferences to be made from these results are that certain stated career plans appear to be much more compatible with later pursuit of a science career than others for individuals of equal Scientific Potential. This compatibility is probably related to the types of college experiences (e.g., majors) that are partially the consequences of the career plans.

Changes in science career plans between 1960 and 1975. In 1960, 18% of the 11th graders had plans to establish their careers in scientific fields. In the data we have collected 15 years later, 20% of the students were planning science careers. Since the 1,142 students tested in 1975 were neither a very large sample nor were they intended to be proportionally representa-

Table 4.8

Percentage of Males in Science Occupations as a Function of Career Plans in High School, Based on Project TALENT Sample

Career Plan	Mean Scientific Potential	Weighted N	Percentage in Science Careers 12 Years Later
Science Career Plans			
Physical Scientist	64.5	26,600	24.1%
Physician	57.7	22,400	15.0%
Biologist	56.3	12,700	15.0%
Political Scientist/Economist	60.7	3,300	12.1%
Engineer	57.1	140,100	11.4%
Pharmacist	53.9	11,100	9.0%
Dentist	53.4	18,000	6.7%
Mathematician	62.4	10,000	6.0%
Sociologist or Psychologist	52.1	5,000	2.9%
Total (Science Plans)	57.6	249,200	12.4%
Nonscience Career Plans			
Medical/Dental Technician	55.2	2,500	28.0%
High School Teacher	55.4	36,200	6.9%
Elementary Teacher	50.0	2,700	6.0%
Accountant	51.4	29,500	5.4%
Armed Forces Officer	51.8	39,100	4.3%
Pilot	52.3	16,100	4.3%
Lawyer	55.4	24,700	4.0%
Professor	62.6	2,400	3.7%
Engineering/Scientific Aide	51.9	10,500	2.9%
Writer	59.6	3,100	2.0%
Some Other Occupation	50.0	105,200	2.0%
Forester	49.8	23,100	1.7%
Cleric, Religious Worker	55.0	13,700	0.9%
Crafts Worker	47.7	11,200	0.9%
Farmer	46.3	30,800	0.7%
Business Executive or Proprietor	52.6	41,800	0.6%
Skilled Trades Worker	48.5	44,400	0.5%
Social Worker	43.9	7,000	0.5%
Police Officer/Fire Fighter	48.3	12,400	0.3%
Salesworker	48.2	8,000	0.3%
Artist	55.1	18,000	0.1%
Enlisted Armed Forces	48.4	23,900	0.1%
Nurse	53.8	2,300	--
Construction Worker	48.4	11,300	--
Homemaker	46.1	1,900	--
Barber/Beautician	44.3	5,700	--
Secretary	43.6	3,900	--
Total (Nonscience Plans)	50.8	531,400	2.3%
Total (Science and Nonscience Plans)	52.7	780,600	5.5%

110

Table 4.9

Percentage of Females in Science Occupations as a Function of Career Plans in High School, Based on Project TALENT Sample

Career Plan	Mean Scientific Potential	Weighted N	Percentage in Science Careers 12 Years Later
Science Career Plans			
Mathematician	61.4	6,000	12.6%
Sociologist/Psychologist	55.7	8,200	6.7%
Physical Scientist	56.2	6,400	4.1%
Physician	57.1	5,600	3.4%
Engineer	57.8	3,300	2.5%
Biologist	55.5	6,000	2.2%
Pharmacist	50.5	4,300	1.5%
Political Scientist/Economist	51.5	2,700	0.9%
Dentist	54.0	1,800	--
Total (Science Plans)	56.2	44,300	5.5%
Nonscience Career Plans			
Lawyer	53.0	5,100	11.7%
High School Teacher	54.4	60,600	3.3%
Writer	56.6	4,400	0.9%
Medical/Dental Technician	51.6	17,100	0.9%
Nurse	49.7	89,300	[illegible]
Elementary Teacher	52.3	63,100	[illegible]
Social Worker	48.0	15,400	[illegible]
Artist	52.8	28,800	0.1%
Some Other Occupation	47.7	73,900	0.1%
Accountant	46.2	20,000	0.1%
Secretary	45.8	205,500	<0.1%
Homemaker	45.7	106,900	<0.1%
Cleric, Religious Worker	50.7	4,200	--
Forester	50.5	1,200	--
Business Executive or Proprietor	49.7	1,100	--
Engineering/Scientific Aide	48.6	800	--
Police Officer/Fire Fighter	48.2	200	--
Pilot	47.7	3,800	--
Professor	45.9	1,700	--
Salesworker	45.7	3,100	--
Armed Forces Officer	44.9	4,900	--
Enlisted Armed Forces	44.0	800	--
Farmer	43.8	1,300	--
Barber/Beautician	42.5	40,000	--
Construction Worker	39.9	500	--
Skilled Trades Worker	38.6	600	--
Total (Nonscience Plans)	48.3	754,300	0.5%
Total (Science and Nonscience Plans)	48.7	798,600	0.8%

111

tive of the entire country, this small difference cannot be construed as indicating a change in young people's interest in entering science.

When career plans were analyzed separately by sex, however, a dramatic change was apparent. More than 3 times as many female high school students were planning careers in science in 1975 as were in 1960! Of the 11th grade Project TALENT participants, 32% of the males and 5% of the females had had science career plans in high school. In contrast, 24% of the males and 17% of the females had science career plans in the 1975 sample. Interest among the males had decreased by one quarter, but the increased interest among females had entirely made up the difference. Furthermore, two-thirds of the females in the 1975 sample were planning "a full-time career (other than housewife) whether or not I get married," and of these career-oriented females 21% were planning to enter science.

An important question is whether the retention rate of those who persist in their science career plans will be lower for females than for males (the retention rate was not as high for females in the 1960 Project TALENT sample). The females with science career plans in the 1975 sample had a mean Scientific Potential score that was a third of a standard deviation below the mean for males with science career plans; this difference in Scientific Potential between the sexes was greater among those with science career plans than among those with nonscience career plans. The difference in scores between the sexes may be due to the lack of nurturance of scientific abilities among young women in our society, and as a result women's moderately high scores may indicate latent abilities equivalent to those of male students who score very high. If today's high school females follow through with their intentions, we will see major changes in the male-female ratio of the entrants to many science fields in a decade.

There are indications already, in fact, that women are entering science programs in greater numbers than ever before. Parrish (1975) has found that the enrollment of women in professional schools increased significantly in 1973-74 and that the increase has accelerated since 1960. Women made up 1% of the total enrollment in dentistry programs in 1960; in 1974 they were 7% of the total enrollment and 11% of the first year students. In engineering, women have increased from 1% of the students in 1960 to 6% of the first year students in 1974. Women were 6% of the medical students in 1960 and 18% in 1974. In veterinary medicine, women were 4% of all students in 1960 and 21% in 1974. If this trend continues, eventually the proportion of full-time employed women who are in science occupations will be as high as the corresponding proportion of men.

The high school students in the 1975 sample were asked which aspects of jobs they anticipated is being important for their future job satisfaction. The aspects seen as most important were that the job be worthwhile and challenging, involve steady work and a good income, be with friendly co-workers, and allow the employees to see the results of their work. Students interested in science occupations tended to indicate that it was important to them that the work be challenging and give them a chance to use their abilities, and unimportant that the job be easy and allow them to retire in 20 years. The only sex differences were on aspects perceived as the least important--early retirement and the difficulty of the job; men considered retirement in 20 years and an easy job to be more important than women did. All the minority groups considered good income to be more important than did the white students, probably because the minority students had experienced more financial difficulties. Retiring in 20 years and having short hours and an easy job were more important to blacks and Spanish surname students than to whites. It was most important to Orientals and least important to blacks that the work be worthwhile.

It appears that not only are the abilities and interests of black and Spanish surname high school students poorly suited to science careers, but also their reward structures do not match the usual rewards in science. Retiring in 20 years and having short hours and an easy job are not common attributes of science careers, while the aspect that was rated lower by blacks than by any other group, that the work be worthwhile, is one of the more important rewards of science. In order to draw greater numbers of underrepresented minorities into science, it may be necessary to develop their appreciation of the rewards intrinsic to scientific activities.

Ethnic and sex differences in specializations within science career plans. Some fields of science attracted approximately equal numbers of male and female high school students in the 1975 sample, but other fields of science were still strongly preferred by one sex.

The biological sciences (biologist, microbiologist, agricultural scientist, and specialist in conservation) attracted 13% of the females and 15% of the males planning careers in science. The medical fields (surgeon, M.D. general practitioner, psychiatrist, dentist, and veterinarian) were also equally favored by both sexes, with 52% of the females with science career plans and 47% of the males. On the other hand, the various engineering fields (civil, electrical, mechanical, chemical, and unclassified engineers) were primarily chosen by males (21% vs. 3% of the females), while the social sciences (psychologist and sociologist) were primarily chosen by females (15% vs. 3% of the males). The particular occupations listed above were the only occupations in each area mentioned by the students; other occupations that would be classified in each group were not chosen by any students.

Although the proportions of male and female high school students who had science career plans were much more similar than they had been 15 years ago, a large ethnic effect still remained. In 1975, 14% of the blacks, 15% of the Spanish surname students, 23% of the whites, and 29% of the Orientals had science career plans.

Figure 4.15 displays the proportion <u>of those planning science careers</u> in each ethnic group who were oriented toward the physical and mathematical sciences, engineering, medicine, biological sciences, social sciences, or some other field of science. (If this figure had been plotted as the proportion of each <u>entire</u> ethnic group, the size of the bars for blacks and Spanish surname students would be roughly half their present size relative to the size of the bars for whites and Orientals.) Nine-tenths of the science career plans fell into one of the five primary groups of science occupations. Blacks chose engineering more frequently than any other group; Spanish surname students chose medicine the most frequently; Orientals and whites chose medicine, the biological sciences, the social sciences, and engineering in descending order of preference. Few of the students named a career in the physical and mathematical sciences.

<u>Career plans of students with high Scientific Potential</u>. Table 4.10 lists all the <u>science</u> career plans chosen by 2 or more students in the 1975 sample in descending order of mean Scientific Potential. The mean Scientific Potential for students with science career plans was almost one standard devi-

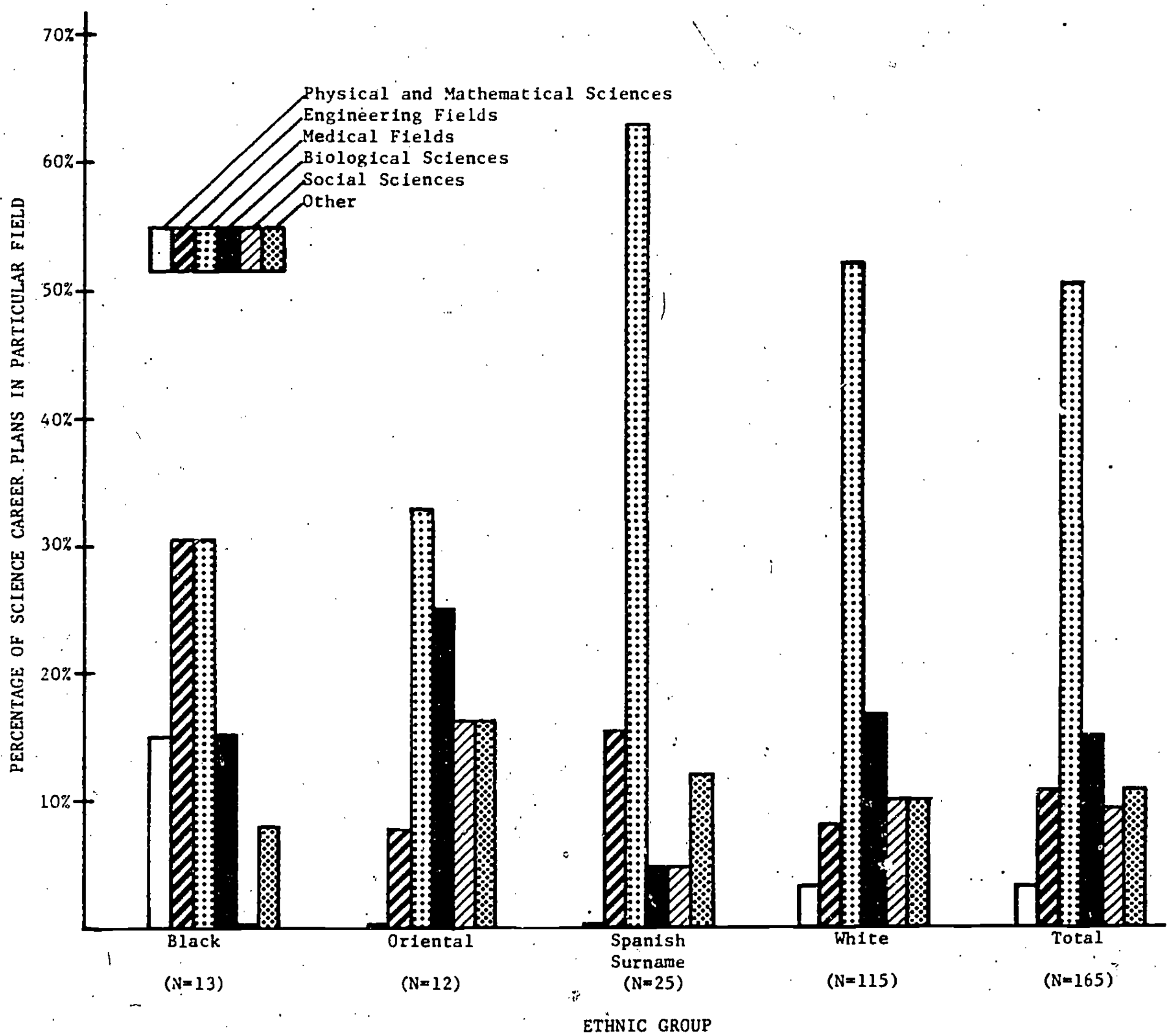


Figure 4.15. Percentages of science career plans in various fields of science, separate by ethnic group, based on the 1975 sample.

ation above the population mean. Life sciences dominate the list. The popular science career plans among students with especially high scores were biologist, psychologist, and M.D. general practitioner. The popular science career plans among students with low scores were unspecified engineers and veterinarian.

All nonscience career plans chosen by 10 or more students are listed in Table 4.11 in descending order of mean Scientific Potential. Only four career plans had mean scores higher than the population mean: computer programmer, lawyer, unspecified teaching, and accountant.

Table 4.10

Mean Scientific Potential for All Science Career Plans with Ns of 2 or More for the 1975 Sample, Both Sexes Combined

Scientific Potential	Occupation	N
64.5	Surgeon	2
63.0	Microbiologist	2
62.3	Biologist	16
60.4	Electrical Engineer	8
59.0	High School Math Teacher	2
58.9	Psychologist	14
58.7	MD General Practitioner	45
58.6	Scientist (unspecified)	5
58.0	Dietitian	2
57.9	Dentist	13
57.5	MEAN SCIENTIFIC POTENTIAL FOR STUDENTS WITH SCIENCE CAREER PLANS	
57.1	Architect	9
56.1	Psychiatrist	7
54.3	Pharmacist	4
53.3	Agricultural Scientist	3
53.3	Engineer (unspecified)	10
51.0	Mathematician	2
50.8	Veterinarian	15
49.8	MEAN SCIENTIFIC POTENTIAL FOR ENTIRE POPULATION	
46.7	Specialist in Conservation	3

What proportion of the potential science resources of this country are lost because talented high school students decide that they are definitely not interested in science careers and would not consider any science occupations for themselves? What are the characteristics of able students who have rejected all science occupations? In order to answer these questions, we studied separately those students who had Scientific Potential scores higher than the mean score for students of their sex with science career plans. In this sample of students with abilities typical of scientists, students without science career plans who responded that they did not want to work in any science-related job were compared with the remainder.

Table 4.11

Mean Scientific Potential for All Nonscience Career Plans with Ns of 10 or More for the 1975 Sample, Both Sexes Combined

Scientific Potential	Occupation	N
58.0	Computer Programmer	13
57.5	MEAN SCIENTIFIC POTENTIAL FOR STUDENTS WITH SCIENCE CAREER PLANS	
54.0	Lawyer	43
53.8	Teaching (unspecified)	26
51.5	Accountant	11
49.8	MEAN SCIENTIFIC POTENTIAL FOR ENTIRE POPULATION	
49.4	Farm Owner	14
48.9	Forest Ranger	17
48.6	Housewife	26
48.0	Graduate Nurse (RN)	26
46.3	Clothing and Fashion Trades	10
46.2	Police	18
44.6	Secretary	30
44.0	Medical or Dental Technician	11
43.6	Social Work	16

Of the 157 females with Scientific Potential scores as high as the mean of females with science career plans, 18, or 11%, would not want any science job in spite of a mean Scientific Potential score of 62.0. Compared to females with high science abilities who had not rejected science, these students were more likely to be white and to have parents who were college graduates. However, their fathers were less likely to have a science occupation. These females were especially likely to be planning to be housewives, either working only until marriage or never holding a job; they tended to believe that science careers delay marriage. They had taken fewer science courses in high school than the comparison group and planned to take fewer additional science courses in high school. They tended to receive lower grades in all their courses except business (e.g., typing, bookkeeping, shorthand) and foreign languages. The high school courses that they thought would be most important to them in the future were more likely to be English or psychology and less likely to be general science. As would be expected, these high ability females who had rejected science careers for themselves were less often planning to take science courses after high school, and they were more likely to expect to terminate their formal education with an A.A., B.A., Ed.D., or J.D. degree and less likely to expect an M.S. or M.D. Finally, when asked which characteristics of jobs they considered to be important, they tended to rate friendly co-workers and short hours as being more important than did the comparison group of high ability females who would consider a science career; seeing the end results of their work and performing challenging and worthwhile work was less important to them.

Of the 155 males with Scientific Potential scores as high as the mean of males with science career plans, 24, or 15%, would not consider any science job in spite of a mean Scientific Potential score of 62.6. When compared to the remainder of the high ability males, they were less likely to be Oriental, and their fathers were likely to have entered college but to have not completed it and were less likely to have science occupations. These students were more likely either to agree with the statement that preparation for a science career would cause them to delay marriage too long, or to respond that they did not know. They had taken fewer science courses in high school and were planning to take fewer additional science courses; they had taken more foreign language, social studies, English, and business courses than had the comparison group of high ability males. They tended to receive lower grades in all courses. The high school courses that they thought would be most important to them in the future were more likely to be history, English, or physical education and less likely to be general science. As would be expected, these high ability males who had rejected science careers for themselves were less likely to plan to take science courses after high school, and they were more likely to expect to terminate their formal education with a B.A., M.A., or J.D., and less likely with an M.S. or M.D. When asked which characteristics of jobs they considered to be important, they tended to rate having a good income as being less important and, unexpectedly, doing worthwhile work as being more important than did the comparison group.

Summarizing these results over the two sexes, the students with high Scientific Potential who had rejected science were usually white with well-educated parents. Their fathers were unlikely to have science occupations, indicating that a lack of role models may be one reason students do not go into science. In spite of being able to score well on the tests administered as part of this project, they tended to report lower grades in most or all of their courses; these students showed evidence of being underachievers. Finally, there were not as many of these students as one might have expected; seven out of every eight students with high Scientific Potential scores had at least not rejected the idea of a science career for themselves, even if science was not at the top of their current lists.

Comparisons between expected job at 20, at 30, and ideal job. When asked what job they expected to have at age 20, 4% of the females and 5% of the males named science occupations. There were even nine students who expected to have an M.D. by then! These expectations were all unrealistic, whether because the students misestimated how old they would be when they finished their educations, because they did not realize the educational requirements of the occupations, or because they were not answering the question seriously. None of the ethnic groups was more prone than the others to having unrealistic expectations of a science occupation at the age of 20.

At first glance, these data would seem to indicate that few students were misestimating the length of time required to prepare for various careers; however, 91% of the students expecting a science job at age 20 also had science career plans for age 30, and therefore 20% of the students with science career plans believed they would be scientists at age 20. When both the science and nonscience jobs planned for age 20 are considered together, 8% require at least a B.A. for certification (including plans to be scientists, engineers, physicians, lawyers, veterinarians, and college professors), while many more of the job plans would be very difficult to achieve without a college education. Without more information about each student's immediate training and job plans, we have not tried to classify all job plans for age 20 as being reasonable or unreasonable, but clearly a sizable minority of high school students need additional information about the preparation and requirements for various careers.

We have already examined the jobs expected at age 30, as this is what we have been referring to as career plans. But how were the expected careers different from the careers that the students would most like to have, their ideal careers? If it were found that many individuals considered science as an ideal career but did not expect to attain a science career, this would indicate that a general fear of failure is an important deterrent of science career development.

Black and white students were slightly more apt to name science occupations as their ideal jobs than as their expected jobs, and Spanish surname students were slightly less likely to name science occupations as their ideal jobs. The largest difference, however, was found with Orientals. The Orientals had the highest percentage expecting a science occupation at age 30 (29%); when asked what job they would most like to have, 45%, nearly half, named science occupations!

We noted earlier that in our 1975 sample almost as many women as men expected to have established a science career at age 30, 17% vs. 24%, respectively. When asked for their ideal occupations, the gap between the sexes closed even more, with 20% of the females and 22% of the males naming a science occupation.

The total proportion of students naming science occupations was virtually unchanged between expected occupation and ideal occupation; however, there was some shifting between the various fields of science. Only half as many students named a field of engineering as their ideal job, while a fifth more named a biological science as their ideal job.

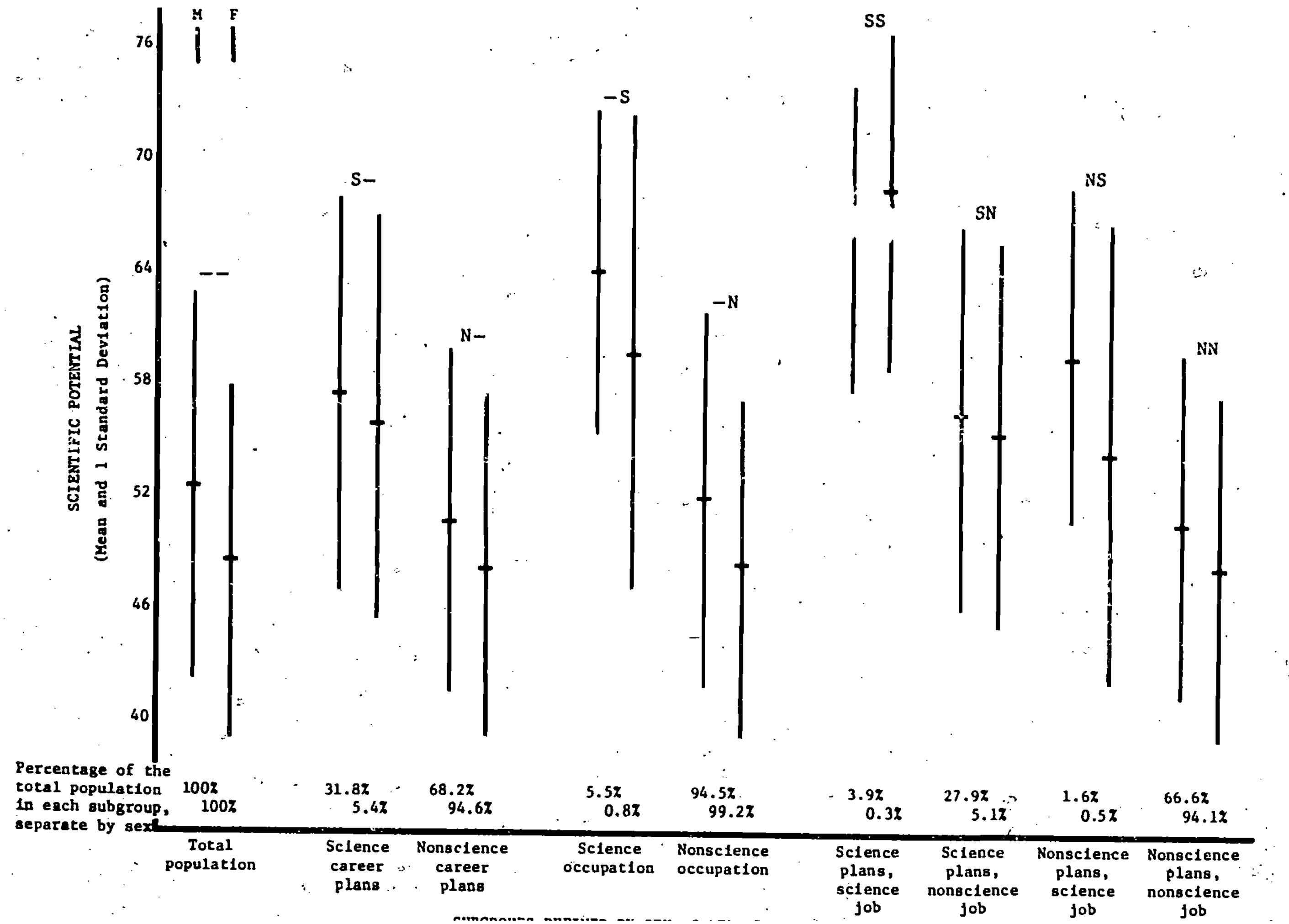
<u>Certainty of career plans</u>. In addition to what their career plans were, the students in the 1975 sample were asked how certain they were of them. The tendency was for black and Spanish surname students to be the most certain of their plans, with fewer of them considering the possibility that some other career might better suit their abilities and interests. Among females, black and Spanish surname females were the most sure of their career plans and Oriental females were the least sure. Black males expressed more certainty than any other group of males. No overall sex effect was evident; males and females were equally certain of their plans.

Students in high school who are certain of their career plans are not necessarily at an advantage relative to their peers. Students at this age should be exploring the possibility of a number of different careers, broadening their horizons with respect to future job opportunities, and learning about the variety of their own interests and abilities. Students with sure career plans may not benefit from future career guidance experiences as much as students who are still trying to decide what they would most like to do. Or conversely, after being exposed to career information, the students who remain certain that a single occupation is the only right one for them may be displaying evidence that they did not benefit from the experiences.

4.9 Occupations at Age 29

Figure 4.16 displays the means and standard deviations of Scientific Potential as a function of career plans and later occupation, separate by sex, from the Project TALENT sample. In 1960, females scored less than one-half standard deviation below males. (In the 1975 sample, the difference was only about one-quarter standard deviation.) Unlike the 1975 data, in the TALENT sample this difference in mean Scientific Potential scores was reduced between males and females with science career plans, but the difference in science abilities was even larger between males and females who established careers in science. The groups with the highest mean Scientific Potential were, of course, the males and females who planned to have science careers and succeeded in doing so. For males, those in science jobs who had nonscience career plans in high school tended to have higher scores than those who had science career plans but ended up in nonscience occupations; the relationship was reversed for females (however, these results for females are based on very small subpopulations).

Science careers. While 5.5% of the Project TALENT 11th grade males had science occupations in 1972, only 0.8% of the 11th grade females entered science careers. The sex effect is not limited to the total number of individuals in science but is as striking when one looks at the types of science occupations held by men and by women. If women are to be properly involved in the technological and scientific decisions that affect the quality of life in this country, they will not only need to train for and enter science careers in greater numbers, but they will also need to consider (and be considered for) a greater variety of scientific fields.


SCIENTIFIC POTENTIAL
(Mean and 1 Standard Deviation)
76
70
64
58
52
46
40
M
F
--
S-
N-
-S
-N
SS
SN
NS
NN
Percentage of the total population in each subgroup, separate by sex
100% 100%
31.8% 5.4%
68.2% 94.6%
5.5% 0.8%
94.5% 99.2%
3.9% 0.3%
27.9% 5.1%
1.6% 0.5%
66.6% 94.1%
Total population
Science career plans
Nonscience career plans
Science occupation
Nonscience occupation
Science plans, science job
Science plans, nonscience job
Nonscience plans, science job
Nonscience plans, nonscience job

All of the science occupations with a weighted N* of 200 or more for 11th grade males are listed in Table 4.12, ordered by mean Scientific Potential from highest to lowest. The mean Scientific Potential scores ranged from a high of 73.5 for M.D.s of unspecified specialties to a low of 55.8 for high school math teachers. The mean Scientific Potential for males in science occupations was 64.2, compared to the overall mean for males of 52.6. All of the science occupations had means higher than the overall mean score for males.

The standard deviation of Scientific Potential tended to be between 8 and 12 for various groups of participants, with an overall standard deviation of 10.2 for males and 9.4 for females. The mean Scientific Potential score for males in science occupations was therefore more than one standard deviation above the mean for all males.

Males tended to cluster into a few categories of science occupations. These categories contained a much lower proportion of the women in science; in fact, our data from the high school class of 1961 indicated that virtually no women had chosen these male-dominated careers. The most populous group of science careers for males was composed of the various engineering occupations, with an estimated total of about 17,500 in the population. The second largest category contained college science and math teachers, with an estimate of about 8,500 in the population. The third category was made up of various kinds of M.D.s, with an estimate of about 7,000 in the population. Architects made up the fourth largest category, with an estimated 3,500 male architects across the country who were in 11th grade in 1960.

Females in science, on the other hand, were found primarily in the social sciences or in teaching high school math and science. The population estimate for high school science and math teachers was 2,600, and the combined estimate for psychologists, research assistants in psychology, and miscellaneous social scientists was 2,300 in the population.

---

*The "weighted N" of a subpopulation of Project TALENT participants is the estimated number of individuals in the continental United States who were eligible to be included in Project TALENT and who would qualify as members of the subpopulation. The total weighted N for 11th grade males is 959,640 and for 11th grade females is 1,007,007.

Table 4.12

Mean Scientific Potential for All Science Occupations with Weighted Ns of 200 or More Males, Based on Project TALENT Sample

Scientific Potential	Occupation	Weighted N
73.5	MD (other and unspecified)	4,800
71.6	Psychiatrist	200
71.2	Surgeon	700
70.8	Microbiologist	500
70.5	Statistican (other, including actuary)	400
70.2	Physicist	400
68.8	Mathematician	200
67.2	Social Scientist (miscellaneous)	600
67.2	Meteorologist	1,500
66.9	MD General Practitioner	1,400
66.6	Aeronautical Engineer	700
66.5	Chemical Engineer	300
66.2	Dentist	2,900
65.9	Chemist	2,100
65.8	Geologist	200
65.0	Architect	3,500
64.8	Specialist in Conservation	1,400
64.6	Civil Engineer	3,800
64.2	Pharmacist	1,900
64.2	MEAN SCIENTIFIC POTENTIAL FOR MALES IN SCIENCE	
64.0	Mechanical Engineer	3,000
63.5	College Math Teacher	900
63.0	Research Assistant in Biology	200
63.0	Electrical Engineer	5,900
62.7	Biologist	700
62.5	Psychologist	500
62.0	Veterinarian	400
61.6	College Science Teacher	2,600
60.9	Research Assistant in Psychology	900
60.8	Engineer (other)	3,700
59.4	High School Science Teacher	4,200
58.4	Psychiatric Social Worker	200
56.4	College Social Science Teacher	5,000
55.8	High School Math Teacher	3,700
52.6	MEAN SCIENTIFIC POTENTIAL FOR ALL MALES	

Of the 51 occupations classified as scientific (see Table 3.1), 33 occupations had weighted Ns (estimates of pouplation frequencies) of 200 or more for males, but only 9 occupations met that criterion for females. The mean Scientific Potential scores of women in those 9 occupations are given in Table 4.13.

Table 4.13

Mean Scientific Potential for All Science Occupations with Weighted Ns of 200 or More Females, Based on Project TALENT Sample

Scientific Potential	Occupation	Weighted N
74.1	Social Scientist (miscellaneous)	700
70.1	Statistician (other, including actuary)	400
66.5	High School Science Teacher	1,600
64.1	Research Assistant in Biology	200
60.0	Research Assistant in Psychology	400
59.9	High School Math Teacher	1,000
59.8	MEAN SCIENTIFIC POTENTIAL FOR FEMALES IN SCIENCE	
57.5	Psychiatric Social Worker	200
57.2	Dietitian	900
49.0	Pharmacist	600
48.6	MEAN SCIENTIFIC POTENTIAL FOR ALL FEMALES	

Females in science had a mean Scientific Potential score of 59.8 versus the 48.6 mean for all females; as with the males, the females in science averaged a standard deviation higher in Scientific Potential than the females not in science occupations.

Nonscience careers. It is a question of some import as to which nonscience occupations attract individuals with high Scientific Potential. Not only are these high ability, nonscience occupations competing with science occupations for the most able students, but these occupations also serve as a reserve of talent for science occupations. In the event that a policy decision is made, as was true in the early 1960s, that our country needs more individuals with scientific training, the students training for these nonscience careers would be most likely to succeed in science programs. Or, of more current interest, if a concerted effort is made to attract greater numbers of qualified women into science, the recruitment will tend to be at the expense of the nonscience occupations that have traditionally attracted women of high Scientific Potential.

Table 4.14 lists the 20 nonscience occupations that had the highest mean scores on Scientific Potential among those with estimated population frequencies of 2,000 or more for males in the high school class of 1961. All of these occupations had mean scores higher than the overall mean for males, and four of the occupations had mean scores on Scientific Potential that were higher than the mean for males in science. These top four occupations were graduate research or teaching assistant, lawyer, computer specialist, and unclassified college teachers. Some of the graduate assistants and college teachers may actually have been working in scientific fields; however, we received insufficient information on their specialties and therefore could not properly classify them as having science occupations. "Computer specialist" is a label that covers a wide variety of occupations, some of which could be considered scientific. Other occupations with high mean Scientific Potential scores were CPA, military officer, and high school English teacher.

Lawyers comprised the largest strictly nonscience occupation with a high mean Scientific Potential score. Shaycoft (1975) also found that lawyers tended to have patterns of abilities and interests similar to scientists. She hypothesized that "many of the same aptitudes are important in law as in science. Lawyers, like scientists, certainly need superior reasoning ability and a logical approach. Lawyers also need a high level of verbal ability--but that is something that scientists, too, find useful" (p. 5-4). For comparison purposes, Figures 4.17 and 4.18 contain the ability and interest profiles of lawyers and college science teachers from Using the TALENT Profiles in Counseling: A Supplement to The Career Data Book (Rossi et al., 1975). As can be seen, lawyers tended to have lower abilities in Mechanical Reasoning and in Visualization in Three Dimensions, but were comparable to the science teachers in the rest of their information and ability scores including the mathematical scales; the major differences between the profiles of lawyers and college science teachers were in their interests, not in their abilities. The population frequency estimate for male lawyers was around 10,000, roughly a fifth the size of all the science occupations combined! If we could ever discover a way of simplifying our laws so that there would be less need for lawyers as mediators and interpreters, we would release a large pool of talent that could well be used elsewhere. Many of the young people who are planning to become lawyers would also make fine scientists, and vice versa, of course.

Table 4.14

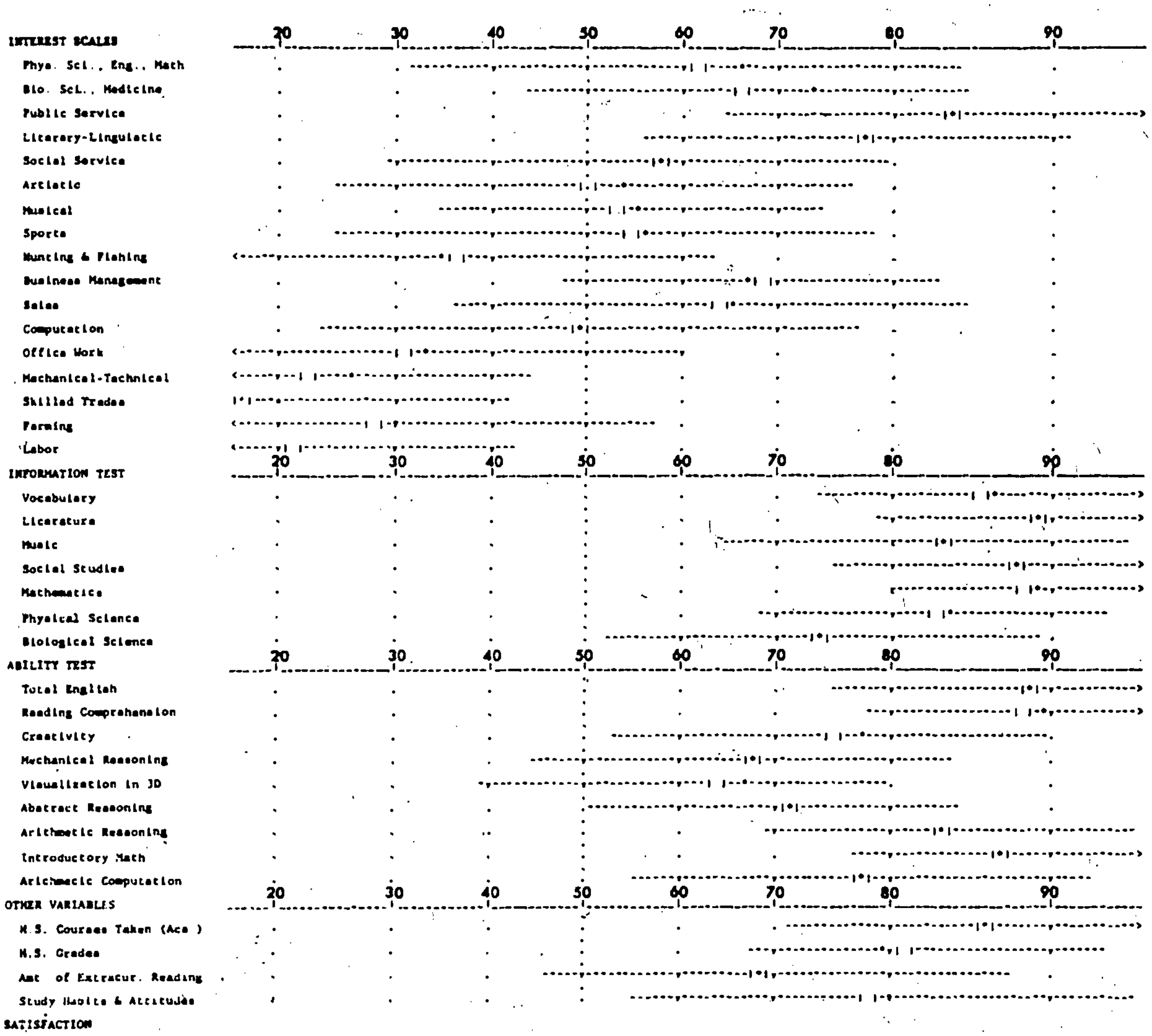
Mean Scientific Potential for the 20 Nonscience Occupations With the Highest Means and With Weighted Ns of 2,000 or More Males, Based on Project TALENT Sample

Scientific Potential	Occupation	Weighted N
66.9	Graduate Research or Teaching Assistant	3,900
65.0	Lawyer	10,100
64.7	Computer Specialist (other)	2,000
64.6	College Teacher (other and unspecified)	6,000
64.2	MEAN SCIENTIFIC POTENTIAL FOR MALES IN SCIENCE	
62.5	CPA	4,300
62.5	Military Officer	3,700
61.3	High School English Teacher	4,300
60.8	Vocational Guidance Counselor	4,500
59.0	Designer of Consumer Goods (except clothing)	6,500
58.9	High School Trade and Industrial Ed Teacher	3,800
58.6	Computer Operator or Supervisor	9,900
58.6	Systems Analyst	6,000
57.4	Stockbroker	4,000
57.4	Real Estate Salesman	2,200
57.2	Advertising	2,600
57.2	Computer Programmer	6,500
57.0	Appraising, Estimating	4,700
57.0	Manufacturing Management	6,100
56.8	Office Supervisor	3,000
56.7	High School Social Studies Teacher	3,000
52.6	MEAN SCIENTIFIC POTENTIAL FOR ALL MALES	

It should also be remembered that occupations with lower mean Scientific Potential scores will nevertheless contain some individuals with high potential for success in science. Occupations with lower mean scores will have lower percentages of such individuals, however, while nonscience occupations with high mean scores will be predominantly composed of individuals who could have succeded in establishing careers in science given the motivation and opportunity.

LAWYER

(n = 5 per 1000)



Aspects of Occupation that Project TALENT Participants Report as Important and Most Satisfying
Relationship of Work to Prior Training
How Well I Can Do the Work
Challenging Work

Aspects of Occupation that Project TALENT Participants Report as Important but Least Satisfying
Income to Start
Quality of Surroundings
Status

(* based on 76% of individuals in occupation)

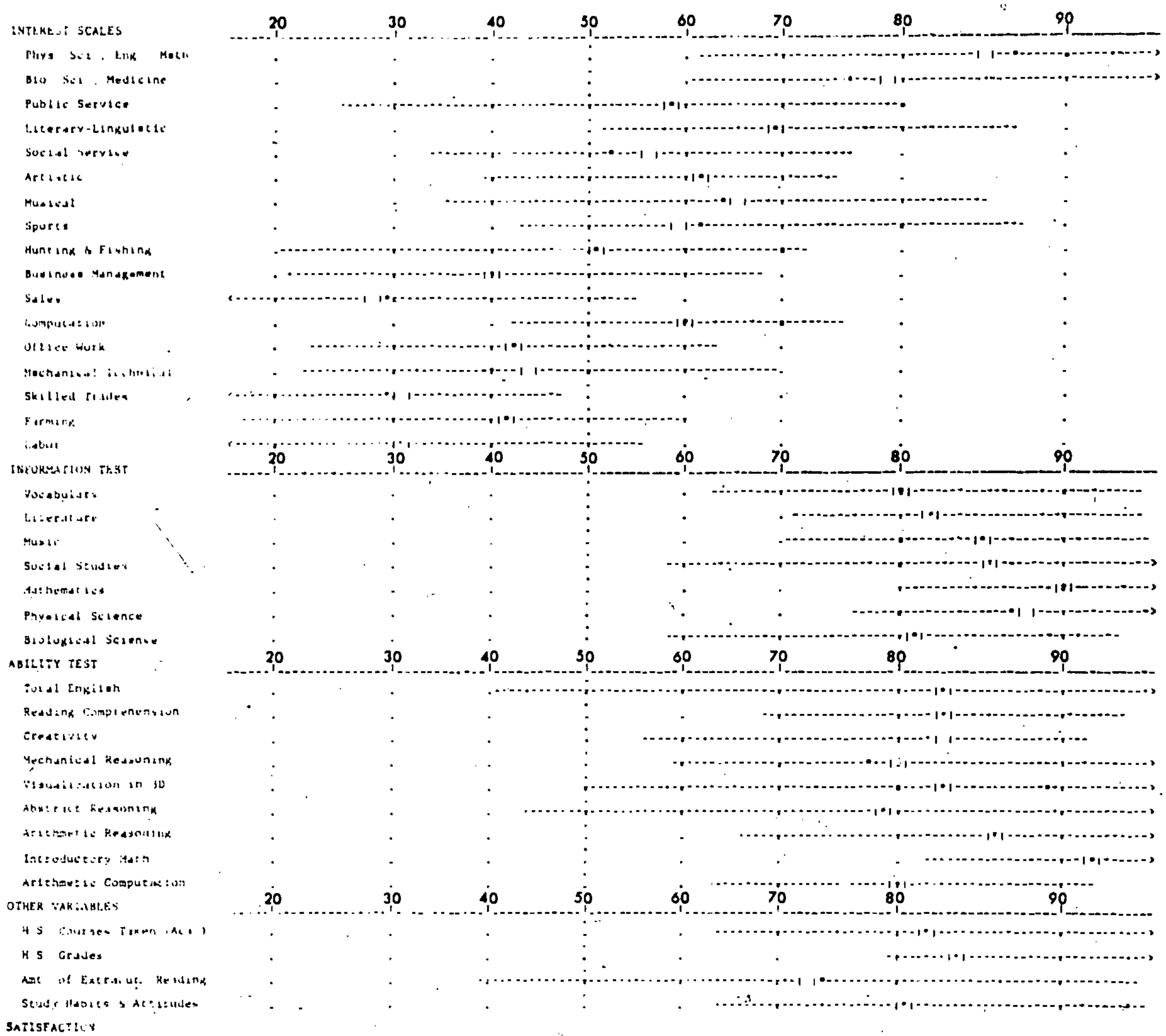
Figure 4.17. Profile of interests and abilities of lawyers (from Rossi et al., 1975).

Note. The asterisks are medians for the 76% in the occupation who reported enjoying their work.

TEACHER: COLLEGE SCIENCE/MATHEMATICS

(Teacher: College Science (74%), Teacher: College Mathematics (26%))

(n = 2 per 1000)



Aspects of Occupation that Project TALENT Participants Report as Important and Most Satisfying
Relationship of Work to Prior Training
How Well I Can Do the Work
Interesting Work

Aspects of Occupation that Project TALENT Participants Report as Important but Least Satisfying
Income to Start
Income Expected
Opportunity to Advance

(* based on 94% of individuals in occupation)

Figure 4.18. Profile of interests and abilities of college science teachers (from Rossi et al., 1975).

Note. The asterisks are medians for the 94% in the occupation who reported enjoying their work.

129

The 20 nonscience occupations with the highest mean Scientific Potential scores among the female members are listed in Table 4.15. Notice that many of the women with highest Scientific Potential were in teaching, primarily below the college level. We discussed earlier the fact that a large proportion of the women in science were also teaching, and again primarily below the college level. There are many reasons why women tend to employ their talents in teaching more than men do, including (a) a stronger orientation towards "people" rather than "things" (Cooley and Lohnes, 1968), which has a cultural basis, whether or not it also has a biological basis; (b) a cultural stereotype of teachers at the lower levels as being women; and (c) sex discrimination in the competition for many of the "higher level" occupations, causing many women to teach for a livelihood when they would prefer to be doing something else.

The largest single nonscience occupation with a high mean Scientific Potential score for women was graduate or registered nurse (RN), with a population frequency estimate of 16,500. This was more than twice as many women as were in all 51 science occupations combined! (The practical nurse group [PN] also contained large numbers of women, but their Scientific Potential was only average.)

If greater numbers of qualified women are to be encouraged to establish careers in science, it appears as though many of them will be drawn from the ranks of high school girls who are planning to be teachers or nurses. There is, however, another group of females that contains a far larger pool of potential scientists: the housewives. Almost one half of all the females in our Project TALENT sample were full-time housewives 11 years after high school. The mean Scientific Potential score for housewives was close to the mean for the rest of the population of females, which suggested that, although the majority of housewives had not developed the abilities necessary for success in science careers, a sizable minority did have the necessary skills. Approximately 10% of the housewives had Scientific Potential scores higher than the mean for women in science, with an estimated population frequency of about 45,000, compared to about 7,000 for all the women in science occupations. Another way of stating the same facts is to note that there were as many housewives with high Scientific Potential as there were women in nonscience careers with high Scientific Potential.

Table 4.15

Mean Scientific Potential for the 20 Nonscience Occupations With the Highest Means and With Weighted Ns of 2,000 or More Females, Based on Project TALENT Sample

Scientific Potential	Occupation	Weighted N
63.6	High School English Teacher	3,800
61.1	College Teacher (other and unspecified)	3,200
59.8	MEAN SCIENTIFIC POTENTIAL FOR FEMALES IN SCIENCE	
57.9	Personnel Administration	2,900
57.0	Student	9,400
56.8	High School Social Studies Teacher	2,000
56.6	Teaching the Handicapped	2,500
56.4	High School Teacher (other and unspecified)	2,500
56.3	Office Manager	3,100
55.7	Music Teacher	4,400
55.3	Banking and Finance	2,100
55.2	Keypunch Instructor or Supervisor	2,200
55.0	Teaching (unspecified)	3,700
54.8	Independent Contractor	4,500
54.7	High School Physical Education Teacher	2,500
54.7	Counseling and Guidance (non-psychologist)	3,000
53.6	Graduate Nurse (RN)	16,500
53.2	Legal Secretary	3,900
52.8	Wholesale or Retail Trade Management	2,000
52.3	Librarian	3,200
52.2	Sales Manager	2,600
48.6	MEAN SCIENTIFIC POTENTIAL FOR ALL FEMALES	

There has been no discussion in this section of the science careers that minorities enter. The reason is that Oriental or Spanish surname participants were not oversampled in Project TALENT and therefore are too few to analyze, and almost none of the black participants had a science occupation 11 years after high school. In Table 4.16, however, we display the nonscience occupations with the highest mean Scientific Potential for black males. The occupation with the highest mean score, business management,

Table 4.16

Mean Scientific Potential for the Nonscience Occupations with the Highest Means and with Weighted Ns of 200 or More Black Males, Based on Project TALENT Sample

Scientific Potential	Occupation	Weighted N
64.2	MEAN SCIENTIFIC POTENTIAL FOR MALES IN SCIENCE	
55.4	Business Management	1,900
53.7	Wholesale or Retail Trade Management	700
53.7	Electrician	800
52.6	MEAN SCIENTIFIC POTENTIAL FOR ALL MALES	
49.5	Real Estate Salesman	600
48.4	Recreation or Playground Director	300
47.6	Machinist	1,100
47.3	Purchasing	1,000
47.2	No job: other	600
46.6	Typist	600
46.0	Auto Mechanic	300
45.5	Lab Technician, Physical Sciences	700
44.9	Phone Installation and Repair	700
43.5	Miscellaneous	200
43.5	Social Work	1,300
43.4	MEAN SCIENTIFIC POTENTIAL FOR BLACK MALES	

was almost a standard deviation below the mean score for all science males. Only three occupations had means as high for black males as the overall male mean of Scientific Potential, 52.6. The mean score for all black males was two standard deviations below the mean for males in science. The mean score for black females was even lower. We must conclude that in 1960 few 11th grade black students had developed the abilities measured by the Project TALENT tests that we found to be correlated with the establishment of careers in science. It may be the case that larger numbers of blacks possessed latent traits necessary for successful science careers but did not manifest them on these particular tests, and because tests similar to the Project TALENT tests have been used as criteria for admission to postsecondary science programs, few of these black students have had the opportunity to become scientists. On the basis of the information currently available to us, however, it appears that few of the black students in high school in 1960 had developed their abilities to the extent needed for a career in science.

4.10 Brief Summary of the Results from the Data Analyses

Data collected by Project TALENT in 1960 from the 11th grade sample and in 1972 from the 11-year follow-up of the same sample, as well as data collected by this Science Career Development Project in 1975 from a new sample of 10th through 12th graders, were analyzed against several different criterion measures using a number of analytic techniques. Our primary interest was in variables that were related to the development of abilities needed in science occupations, to plans to work in a scientific field, and to general career development experiences, opportunities, and hindrances.

There were only minimal differences in mean Scientific Potential between males and females; females averaged less than one-half standard deviation below males in 1960 and approximately one-quarter standard deviation below males in 1975. On the other hand, large differences were found among the four major ethnic groups in the 1975 sample, with blacks and Spanish surname students scoring one standard deviation or more below whites and Orientals.

Various aspects and dimensions of social advantage were positively related to Scientific Potential. However, the partial correlations between SES and a science career, controlling for Scientific Potential, were very low. The effects, in terms of entering or not entering a science career, of the socioeconomic status of one's family appear to be mediated almost entirely through abilities that have developed by 11th grade; given equal abilities, SES has little relation after high school to achieving a science career.

Parents' level of education displayed a strong relation to their offspring's career plans in high school. If either parent had attended college, the student was much more likely to have a science career plan; this relation was as strong for parents who had <u>not</u> completed college as for parents who had graduated.

Individuals with science career plans in high school tended to have an intellectual and academic orientation to their social activities, hobbies, and leisure activities, and they gave indications of being socially backward or introverted. Males who went into science had much better study habits and grades than their male peers; this relation was less evident for females. The particular set of characteristics that distinguished females who established science careers from those who did not centered on greater amounts of extracurricular reading and greater numbers of magazines in the home.

Black and Spanish surname students took fewer science and math courses than did white and Oriental students. Since the Scientific Potential index is based in part on knowledge and abilities in mathematics and the sciences, the black and Spanish surname students received lower Scientific Potential scores partially because they chose to take fewer math and science courses. If they had become interested in science early in high school and had taken as many math and science courses as the white and Oriental students, they would certainly have received higher scores than they did, regardless of their general abilities upon entering high school.

The amount of school time students reported spending in each of several career education activities was related to planning a science career; students who spent more time in career guidance activities were more likely to expect to have a science occupation at age 30. Students with science career plans also tended to have more accurate knowledge about careers. There were very few differences between the sexes in self-perceptions and perceptions of careers; however, the minorities underrepresented in science were significantly less accurate than others in their estimates of their relative abilities, interests, and values and in their estimates concerning people in selected occupations.

Students generally tended to underestimate the abilities of chemists (the science occupation in the questionnaire) and to overestimate chemists' levels of interest in areas other than science. There were large and consistent differences among the profiles estimated by the four ethnic groups. In particular, the underrepresented minorities estimated that chemists had lower abilities than did whites and Orientals, especially ability in mathematics and knowledge in science, and blacks and Spanish surname students estimated a lower interest in science for chemists. As a result, there were no significant differences among the ethnic groups in the similarity of their self-images to their images of chemists, but Spanish surname and black students were significantly less accurate in their estimates of chemists.

As would be expected, students with high Scientific Potential and students with science career plans were much more ambitious in their postsecondary educational plans than other students. Most of these students were planning to earn at least a master's degree. Of the students with Scientific Potential scores in the upper third of the 1975 sample, 94% of the females and 97% of the males are planning to complete four years of college.

However, some of these students with high Scientific Potential scores would not consider working in any science occupation. These students were more likely to be white, to have well-educated parents, and to report low grades than a comparison group of high science ability students who had not rejected all science careers. The number of these students rejecting science was not large; seven out of every eight students with high Scientific Potential scores had not rejected the idea of a science career, although only about 40% were specifically planning one.

Science career plans had a large partial correlation with entering a science career after controlling for Scientific Potential; plans to work in a scientific field did influence a student's chances of achieving a science career independently of his or her abilities. On the other hand, only 12% of the males and 6% of the females who were planning a science career while in 11th grade actually persisted in their plans over the next twelve years; a quarter of the men and over half of the women in science in 1972 had had nonscience career plans in high school in 1960. The number of students with science career plans in 1960 was approximately six times the number of science jobs available to their grade-cohort in 1972; given this mismatch between plans and availability of jobs and the inevitable competition for the relatively few science jobs, it is surprising that a substantial proportion of 29-year-old scientists in 1972 were not planning on a science career in high school.

More than 3 times as many female high school students were reers in science in 1975 as were in 1960. Of the 11th grade Pr participants, 32% of the males and 5% of the females had had sc plans in high school. In contrast, 24% of the males and 17% of had science career plans in the 1975 sample. Furthermore, two- the females in 1975 were planning to pursue full-time careers (housewife) whether or not they got married, and of these career females 21% were planning to enter science.

Although the proportions of high school students with scie plans who were male and female were much closer in 1975 than in were still some large differences between the sexes in their ch ence specializations; the various engineering fields were prima by males in 1975, while the social sciences were primarily chos The biological and medical sciences predominated in the 1975 sc choices, and almost no students chose any of the physical scien

The 1975 sample exhibited less remaining sex effect on scie plans, but large differences were still evident between the vari groups; 14% of the blacks, 15% of the Spanish surname students, whites, and 29% of the Orientals had science career plans.

For both males and females in both the Project TALENT sampl Science Career Development sample, students <u>with science career</u> mean Scientific Potential scores approximately three-quarters of deviation above the means for the comparable total populations. the Project TALENT sample, males and females <u>in science careers</u> had mean Scientific Potential scores one standard deviation or m the means for the total populations of males and females.

Women in the Project TALENT sample who were in science care to be in the social sciences or in teaching science at the high The nonscience occupation that contained the largest numbers of high Scientific Potential was the legal profession; the ability profile of lawyers is similar to the profiles of many science oc The nonscience occupations, other than homemaking that contained numbers of women with high Scientific Potential were the various of teaching and registered nurses. Black men with high Scientific Potential tended to be employed in business management.

137

CHAPTER 5

Conclusion and Recommendations for Future Research

5.1 Conclusion and Discussion

Some of the highlights of the report are reviewed and discussed in this section, organized according to the seven objectives listed in Section 1.2.

Objective 1: Development of a Scientific Potential index based on differences in high school ability between scientists and others, and observation of the correlates of Scientific Potential.

This study resulted in the production of an index of Scientific Potential composed of the ability scores of 11th graders that best predicts establishment of a scientific career after completion of formal education. This index has been validated over a 12-year period and has been found to be correlated with eminence within scientific fields.

Students with high Scientific Potential tended to have taken more mathematics and foreign language courses, to have been enrolled in college preparatory programs, and to have had high educational expectations, and to a lesser extent they tended to have taken the National Merit Scholarship tests, to have come from high SES families, to have been more interested in physical science and math, to have believed that a college degree was necessary for their career choices, and to have had their high educational expectations reinforced by high expectations of both parents and peers.

The Scientific Potential index proved to be a useful tool for analyzing the nonability career development factors that act as facilitators or barriers on the path toward a career in science. For example, although two variables, SES and science career plans, were both correlated with successful establishment of a science career, when the relations with Scientific Potential were controlled the predictive value of SES, but not of career plans, was markedly reduced. Thus, interventions that might improve certain aspects of the home environments of young people should be evaluated primarily on the basis of whether they cause an increase in abilities, if they are to be effective in increasing the access of low SES students to scientific careers. On the other hand, later interventions that increase the frequency of science career plans in a group of high ability students may increase the number entering science even if abilities are unchanged.

Objective 2: Identification and measurement of nonability variables that are predictive of establishment of a career in science for individuals with equal Scientific Potential.

Some of the variables with the highest correlations with establishing a career in science after partialing out Scientific Potential were, for males, science career plans, having taken the National Merit Scholarship tests, good study habits and attitudes, high grades, saving money primarily for college, and being enrolled in a college preparatory program; and for females, science career plans, often discussing college plans with the school counselor, expecting college expenses to be covered by scholarships, low interest in office work, and high minimum acceptable income.

The socioeconomic status of students' families exhibited little relation to entering a science career after partialing out Scientific Potential. It appears from this result that most of the advantages which wealthier families were able to give to their children affected the development of abilities prior to high school; for students of equal abilities in 11th grade, the SES of their parents did not seem to influence the students' chances of succeeding in establishing a science career.

This finding is surprising for two reasons. First, higher SES families can better afford to send their children to college, and a bachelor's degree was required by the definition of "scientist" used in these analyses. Second, the 1975 data exhibited a strong relation between the amount of parents' education (which was part of the operational definition of SES in the TALENT data) and science career plans in high school. In particular, if a student's parents had attended college for a year or more, even if they did not graduate, the student was much more likely to choose a science career. Because of the possibility that the effect was an artifact of differences in parents' level of education in the various ethnic groups, the data were analyzed separately for whites; parents' education continued to be strongly related to science career plans.

It would be very interesting to know how this relationship is mediated. There may be crucial aspects of the home environments of students whose parents attended college that could relatively easily be made more available to students whose parents did not continue beyond a high school education.

Science career plans displayed one of the largest partial correlations with having a science occupation 12 years later after controlling for Scientific Potential. Planning to enter science seemed not merely to reflect high abilities, but rather to be related to successfully establishing a science career independent of abilities. For high school students who have already exhibited high levels of the abilities needed in science, no single influence seems to affect the proportion with science careers a decade later as much as convincing them to try.

Certain ethical considerations are raised by any attempt to influence high school students' career plans (although lack of information or guidance is also an influence). Based on the experiences of the males in the Project TALENT sample, only one out of eight 11th grade students with science career plans persisted on that path over the next dozen years. If greater numbers of less able students were influenced to plan for science careers, presumably even fewer of them would succeed. Very little is known at present about individuals who switched from science to nonscience career plans after high school. It is possible that many of them found their science training useful in nonscience careers; it is also possible that many were harmed by the experience of failing to meet the high standards of science fields and that their career development was delayed by the change in career plans. Until more is known about the later job satisfaction and success of individuals who attempted to prepare for science careers but later changed their plans, students should not be indiscriminately influenced to go into science.

Objective 3: Comparison of differences in Scientific Potential and its relationships to science career plans for various subgroups of students.

The most striking difference between the 1960 Project TALENT data and the 1975 Science Career Development data was the tremendous increase in the frequency of science career plans among women. Almost as many females as males in high school in 1975 were planning to prepare for careers in science, approximately one out of every five students. It is worth noting that the definition of "science" used by this project does not include nurses or laboratory technicians, but only researchers and upper-level practitioners in fields that are intensively involved with science and mathematics.

It was evident from the 1960 sample that females were developing the skills needed in science. Females scored less than a half standard deviation below males on the index of Scientific Potential, which heavily weights mathematical abilities and mechanical reasoning, abilities which have been fostered primarily in males in our society. In the 1975 sample, females scored only one-quarter of a standard deviation below males. The abilities to perform well in the scientific fields, coupled with the desire to work in science, should result in a much higher proportion of females successfully pursuing science careers during the next decade or two. Parrish (1975) has reported that in recent years the number of women in graduate science programs has increased dramatically.

On the other hand, the career plans expressed by the females in the 1975 sample still tended to cluster in different specialties of science from the male science career plans. Females were continuing to avoid the engineering fields, and instead many were planning to enter the social sciences, the science fields in which they have previously been best represented. If women are to influence research and policy decisions and to serve as role models to young girls in <u>all</u> areas of science, then it is necessary to draw women in greater numbers to the "hard" sciences. Women appear to have discarded the stereotype that science is a man's world, but they continue to some extent to follow the stereotypes of male-female fields within science.

Progress was not as evident with respect to the underrepresented minorities in science, blacks and Spanish surname individuals. The percentage of these minorities planning science careers while in high school in 1975 was only slightly more than half the percentage of whites planning science careers. Furthermore, unlike the females the minorities appeared <u>not</u> to have developed the abilities needed in science. In both the 1960 sample and the 1975 sample, black high school students averaged one standard deviation below the mean on Scientific Potential; the gap had not narrowed during the intervening 15 years. Only 3% of the black students, as compared to 15% of the general population, had scores as high as the mean of those who successfully established careers in science. Almost none of the black students in the Project TALENT 11th grade sample had jobs in science in 1972-1973.

These results can be expressed in another way that offers more promise for increasing the numbers of qualified blacks in science. Obviously, approximately half of the individuals in science jobs had abilities below the mean for people in science. A more meaningful standard, therefore, for assessing what proportion of blacks had the abilities to enter science would be some minimal level of abilities that are essential, rather than the mean abilities of individuals in science. A plausible minimum level of Scientific Potential for pursuit of a science career is one standard deviation below the mean for individuals in science in the Project TALENT sample. This score is roughly the 15th percentile for the population of these individuals in science. Approximately 15% of the blacks, and 50% of the total population, had scores as high as this minimum standard.

In order to increase the representation of blacks (and other underrepresented minorities) in science fields, it will be necessary first to identify the 10%-15% of the ethnic group who have best developed the abilities needed in science. Special efforts can be made to assist the individuals in this select group who are interested in the prospects of a career in science. However, until better methods are devised to help black students overcome the effects of social deprivation and develop the needed abilities <u>prior to high school</u>, blacks will continue to be underrepresented in the sciences. The barriers that prevent blacks from having equal opportunity to enter science careers appear to operate primarily before the high school years.

Objective 4: Identification and measurement of knowledge, about science careers and about one's own abilities and motivations, that is related to the realization of high school students' Scientific Potential through planning for a career in science.

A primary objective of this project has been to assess the level of knowledge high school students possess concerning science careers, their knowledge of themselves, and their understanding and appreciation of the process of career development. Our findings were rather remarkable: students' most accurate estimates were of the characteristics of scientists; they less accurately estimated other careers; and they were least accurate in their self-estimates. Because our results also indicated that they were planning to pursue careers that they perceived as populated by individuals similar to themselves, it would seem imperative to develop methods for helping students to measure their abilities and interests relative to their peers.

There were marked ethnic differences in career and self-knowledge and in appreciation of the importance of career development activities. The underrepresented minorities, blacks and Spanish surname students, showed a uniformly greater need for such knowledge inputs than their white and Oriental counterparts. Furthermore, our data indicate that by high school the dimensions on which there were the greatest differences between the self-perceptions of blacks and Spanish surname students and the self-perceptions of whites and Orientals were just those dimensions that characterized students' images of people in science careers.

In a number of ways, the black and Spanish surname students exhibited a lack of knowledge about careers and the preparation necessary for careers relative to the white and Oriental students. When estimating the abilities, knowledge, and interests of chemists, computer operators, and sales clerks, the black and Spanish students tended to underestimate the chemists and overestimate the sales clerks, resulting in more similar estimated profiles for people in the two occupations. Similarly, when estimating the expected income and required education for five occupations, Orientals and whites tended to view the occupations as being more different from each other (and accurately so) than did blacks and Spanish surname students; a majority of the latter two groups thought that truck drivers and sales clerks were required to have at least two years of college education! These data indicate that misconceptions of career development are frequent and could be solved by providing more complete information in this area in high school.

Women in this sample exhibited few significant differences from men on these knowledge components. However, women students did view themselves as significantly less like chemists than did men ("chemist" was used as the specific occupation in science for this assessment).

Objective 5: Determination of the extent to which career development problems are due to misconceptions of career development and can therefore be solved by providing instruction in this area in high school.

When asked what jobs they expected to have at age 20, 20% of the students with science career plans believed they would be scientists by that age. When both the science and nonscience jobs planned for age 20 are considered together, 8% require at least a B.A. for certification (including plans to be scientists, engineers, physicians, lawyers, veterinarians, and college professors), while many more of the job plans would be very difficult to achieve without a college education. Clearly, a sizable minority of high school students need additional information about the preparation and requirements for various careers.

When students were asked how sure they were of their career plans, 30% responded with one of the top two values of a five-point certainty scale. This is a surprisingly high percentage, given that they had numerous career possibilities open to them, most of them were only in 10th or 11th grade, and many of them were planning to attend college. Black students were the most certain of their career plans, with 52% being completely sure or very sure. Students at this age should be exploring the possibility of a number of different careers, broadening their horizons with respect to future job opportunities, and learning about the variety of their own interests and abilities. Students who are most certain of their career plans may not benefit as much from career education information as students who are still trying to decide what they would most like to do.

The career development of women is highly dependent on how men and women in our society estimate the abilities of women relative to the abilities of men, especially concerning the kinds of jobs women could perform. The high school students in the 1975 sample were asked whether women could do the same kind of work as men; 11% of the females and 25% of the males responded that not very often or never could a woman do the same kind of work as a man. It is quite possible in the light of these responses that some females who would otherwise be interested in science do not prepare for science careers because they believe that science is not the kind of work that a woman can do. It is clearly a responsibility of our society, and especially of the educational system, to inform all young people that the vast majority of jobs could be performed by either sex. Female role models and guest speakers and discussions of the subject with students would probably improve the situation.

Objective 6: Identification of sources of influence and knowledge related to career development.

The sources that most influenced students' career choices were parents and other relatives (28%) and people on the job, observation of workers, or job experience (13%); 17% said that they had not been influenced by anyone--a dubious response. The counseling department or career center was mentioned by only 2% of the students, and other school personnel, special courses, and schooling in general accounted for another 10% of the responses. Although the educational system has the potential for supplying the information needed by students to decide on the careers that best suit them, seven out of every eight students who responded to the question named some source of information other than schooling and counseling as having been most influential.

The career education activities that students thought were most useful for acquring information about jobs were (1) job experience, (2) touring businesses, (3) taking tests, and (4) listening to guest speakers describe jobs. The various groups of students generally agreed on the usefulness of the activities, except that black students rated guest speakers less helpful and career education classes and school counselors more helpful than did the other students. The amount of time that students reported spending in various career education activities during school hours roughly corresponded to the perceived usefulness of those activities.

Eight out of ten students reported talking to people at school about careers, and an equal number reported talking to people out of school about careers. In school, they most frequently talked with friends (55%), and more rarely counselors (17%), teachers (13%), or career center workers (6%). Out of school, they most frequently talked about possible careers with their parents of the same sex--mothers for females (43% vs. 16% with father) and fathers for males (34% vs. 20% with mother). Other primary sources of information outside of school were friends (24%) and a person in a job (8%).

Consistently on these and other items in the questionnaire administered to the 1975 sample, friends and parents are reported as being the prime sources of information about occupations and career development. Although family and peers are the main sources of students' values and aspirations, they are usually not as qualified to provide objective information about the characteristics and requirements of the full range of careers open to students. Career decisions are still largely divorced from the information supplied as part of formal schooling.

Objective 7: Provide the foundation for developing a procedure for evaluation of the effectiveness of high school programs in terms of their guidance of students toward careers appropriate to their scientific ability potential.

In the course of the project, a comprehensive questionnaire was developed that assesses high school activities, experiences, career development, career and self-knowledge, and career plans, and the Project TALENT test battery was adapted for the assessment of Scientific Potential. These two instruments could be used for future research and evaluation studies of scientific manpower resources.

Having said this, we can list two cautions for use of the index of Scientific Potential. First, it has been developed only as a unidimensional score. An index validated purely on physical sciences and one validated on social sciences may indicate important variations in skills across sciences that are hidden in the unidimensional measure. Second, we have not yet estimated how <u>changeable</u> the scores on the Scientific Potential index might be. Although the tests are quite "reliable," the crucial question is whether taking a youth of average ability and little interest in science and creating an intense interest in science in him or her can lead to dramatic changes in his or her ability development, and if so, to what extent and in what age ranges.

Despite these cautions, we have found the Scientific Potential index to be useful in separating ability from nonability factors affecting the development of scientific careers, and we feel that with some additional work we would recommend its use to other researchers and as a component of an instrument for the evaluation of high school science programs. In addition, the

Career Planning Survey could be tailored to the particular task of evaluating the effectiveness of high school programs in terms of their guidance of students toward careers appropriate to their scientific ability potential. The modified questionnaire in conjunction with the Scientific Potential index could be used to assess various innovative programs in order to select the most effective techniques for wide-scale implementation.

In summary, the Science Career Development Project found that about one high school student in five in 1975 was planning a science career, approximately the same proportion as in 1960. Females in high school have developed the abilities necessary to establish a career in science to almost the same degree as have males, and now, as opposed to 15 years ago, almost as many high school females as males have science career plans. Blacks and Spanish surname students, on the other hand, do not appear to have developed the necessary abilities by high school, suggesting that interventions may be needed before and during high school to help them develop more fully their abilities in science. Notably, underrepresented minorities were significantly less accurate than others in their knowledge of their own abilities, interests, and values and in their knowledge concerning people in selected occupations. This information is crucial to healthy, adaptive career decision-making, and can easily be supplied in the context of existing career guidance programs. Many students, especially science students, had unrealistic career plans, such as expecting to be a certified professional before completing college; again, better information concerning the career development process typical of various families of careers could be supplied as part of the career guidance program or in subject-matter courses. The minorities underrepresented in science tended to be particularly certain in their high school career plans, and all groups of students rated knowledge of what other careers are related to their interests as being the least important career guidance knowledge; many may not have given the full range of science careers a careful consideration. The blacks and Spanish surname students of both sexes were more likely to believe that women cannot perform the same work as men; since the sciences have traditionally been dominated by males, some minority women may assume that because of their sex as well as their ethnic status they cannot establish a career in science. Science career guidance in the high schools can clearly be improved by making available more information to the students about themselves, about careers, and about the career development process. High school students would welcome this information.

5.2 Recommendations for Future Research

During the course of science career development in high school, through college and possibly graduate school, and into the work world, certain decisions are most likely to have an impact on whether a person ever holds a science-related job and, if so, how productive and successful the person would be in a science field. The most crucial of these career development decisions are:

1. whether to have science or nonscience career plans in high school;
2. which college to attend;
3. whether to elect a science or nonscience major (and minor) in college;
4. whether to go to graduate school in science;
5. which graduate school;
6. whether to take a science or nonscience job; and
7. whether to remain in a science occupation or to switch to a nonscience career.

Actions and policies that affect the way that people with high levels of scientific potential make these career decisions, by either supplying incentives, eliminating barriers, making information available, or improving career guidance, are most likely to produce an improvement in the development of potential science talent in this country.

The Science Career Development Project has focused almost exclusively on characteristics of students during the high school years. These analyses have shed considerable light on how student characteristics are related to Decision 1, and recommendations have been made throughout the report of how high schools could best help students make career decisions that best fit their interests and abilities. Future research of this kind needs to be concerned with the later science career development decisions.

Our survey of the literature relevant to the career development of individuals in science and the results that have already accrued from this project lead to recommendations about long-range research needs and plans for meeting them. These research plans would make use of our findings as part of their groundwork and would build beyond the topics that have been analyzed here. The suggested research topics are (1) an assessment of the effects of post-high school variables on the career development of scientists, especially of women who develop an interest in science after high school; (2) an assessment of the effects of the quality of undergraduate and graduate education on science-related careers; and (3) an examination of various dimensions of dissatisfaction in science careers and of the variables related to high job satisfaction in science. The first research topic would examine the variables that affect Decisions 2-6 for the subpopulation of women who are "late bloomers" in science; the second research topic would examine more closely the effects of Decisions 2 and 5 on later science career development in various fields of science; and the third research topic would examine one of the primary determinants of Decision 7, job satisfaction in science.

1. Effects of post-high school variables on science career development, especially in women. The present project has found that more than half of the female 11th-grade TALENT participants who were in science occupations in 1972 did not have science career plans in high school in 1960. What were they planning? How did they get into science? What influenced them? Could they have made use of better career guidance in high school or in college? We suspect that the science career development of women is more dependent on post-high school factors than for men. This hypothesis is supported by the literature (Eiduson, 1973) that indicates that women who become interested in science tend to do so at a later age than men.

The Science Career Development Project has made use almost exclusively of variables pertaining to the high school years. Project TALENT, however, has extensive additional data on the experiences after high school of all follow-up respondents. A study building upon the Project TALENT analyses in the present project could investigate the effects of post-high school variables on entering a science career when controlling for Scientific Potential, family background, and high school experiences and plans. Variables that could potentially be explored include amount of education, type of undergraduate and graduate school, college major and minor, marriage, number of children, when the children were born, and previous occupational history. A research project of this kind could reveal the opportunities and experiences during the college years that influence individuals to enter whether or not they had science career plans in high school.

2. Effects of the quality of undergraduate and graduat science-related careers. Every year approximately two milli seniors must decide what kind of college to attend, and hund of college seniors decide on a graduate department. Many of are interested in science-related careers. Given the great c sible educational experiences in this country, it is often ve for these students to determine what kind of program and what would best further their plans and aspirations.

A. W. Astin (1963) conducted a 4-year longitudinal study tude students who attended 85 undergraduate institutions. A motivation to pursue a career in science tended to increase d at a technological institution or a coeducational liberal art tended to decrease during attendance at one of the men's coll Northeast. In another study, Crane (1965) concluded that "th which a scientist receives his training has more effect on hi tivity than the setting in which he works afterwards"!

One can easily think of prima facie arguments for attend vate college or a large university, a school that emphasizes or a school that encourages research and publication by the f a school without a graduate program or a school known for its gram. However, the student who is deciding usually does not factual information about how these and other variables are l the quality of his or her postsecondary educational experienc tion for a science career. What is needed by individuals who confronted by these decisions is a careful comparison of stud ilar abilities and interests who have attended different kind and graduate schools with respect to their later career attai satisfaction.

Individuals who are currently in science careers could b in terms of the types of colleges and graduate schools they a the resulting groups could be compared by ability and interes in high school and by their present career attainment. The c of colleges and graduate departments on various dimensions would require some investigation involving sources such as the Comparative Guide to American Colleges (Cass and Birnbaum, 1973) and A Rating of Graduate Programs (Roose and Andersen, 1970) and possibly even contacting the schools when published information is lacking about their programs. Such an analysis could provide in-depth information related to the following kinds of questions:

1. What effects does the kind of college attended have on the careers of people in science? A community college for the first two years vs. a four-year college for all four years? A small liberal arts college vs. a university vs. a science and technology institute? A "prestige" department in a science field vs. a "second-rate" department vs. an unknown department? A college with a graduate program in that field vs. a college with no graduate students? With vs. without much research and publication by the faculty members? With vs. without emphasis on the quality of undergraduate teaching?

2. Do the effects from the kind of college attended vary for different fields of science? The social sciences vs. the physical sciences?

3. What differentiates the students who choose one kind of college over another?

4. What kinds of occupations do students enter after having earned degrees at various kinds of colleges?

The information gathered on how the kind of college attended is related to the later careers of science majors would not only be of critical importance to students who are planning to enter science-related careers, but would also indicate to colleges and science departments what the consequences of some of their policy decisions might be for the students. If such a study were to have any appreciable impact on the needs of individuals, however, it would be crucial that various modes of dissemination of the results be developed. In particular, methods should be explored for describing the results directly to those students and their parents who will be making the educational decisions. Proper dissemination vehicles might include magazine articles, and pamphlets that could be distributed through the local high schools or sold at a low cost.

3. Satisfaction and dissatisfaction in science careers. Several studies, such as that by Nordstrom and Friedenberg (1961), have shown that a significant number of highly qualified people have turned away from science careers because of dissatisfaction with particular aspects of scientific work. The wide range of scientific and technical problems that currently confront us demand the fullest development of our nation's scientific talent. It is essential, therefore, that future research identify aspects of science careers that deter talented youth from entering them and that contribute to scientists' decisions to leave successful science careers. In addition, methods should be sought for attenuating this exodus.

Project TALENT respondents in various careers evaluated the importance of up to 20 aspects of jobs and rated their satisfaction with their current job on each of these dimensions. Using the TALENT Profiles in Counseling: A Supplement to the Career Data Book (Rossi et al., 1975) reports the job aspects with the highest and lowest satisfaction ratings among those aspects considered to be important by individuals in each occupation. It shows, for example, that the lack of opportunity for advancement is an area of dissatisfaction common to many science careers. On the other hand, scientists rate the interest and importance of their work as more satisfying aspects of their occupation. Salary level is rated as satisfying by a majority of scientists in some science careers but is a dissatisfaction among most scientists in other science careers.

Some of the questions to be answered by examining data on job satisfaction in science careers are: (1) Do women and minorities in science careers have different priorities of job aspects than white males, and are these groups less satisfied? (2) How many people are frustrated because they are over- or undereducated for the career in which they are employed? (3) Do people's ratings of the importance and satisfaction of various job aspects change as they gain experience in science careers (as stereotypes are replaced with experience)? (4) Do people who are dissatisfied with science careers have different priorities from those who are satisfied in terms of the importance of different job aspects? (5) What is the relation of scientific abilities to job satisfaction?

152

A study of this kind should concentrate on three groups of individuals: those who are in science careers and are highly satisfied with their jobs, those who are in science careers but are dissatisfied with their jobs, and people who are not in science careers but who had high Scientific Potential when they were in high school. The last group should also be split between those who once planned a career in the sciences and those who never planned such a career.

The first step in the analysis should be to identify variations between scientific fields in both the overall level of satisfaction of their members and satisfaction or lack of it with particular characteristics of their jobs. The differences in level of satisfaction and in patterns of satisfaction and dissatisfaction should be examined, with the hope of developing a model that would be applicable to most or all fields within the sciences. This model would incorporate relationships between the pattern of perceived importances of the job aspects and the ratings of satisfaction.

The second step in the analysis should be the refinement of the job satisfaction model in order to account for individual differences, using background variables such as interests and aptitudes, educational experiences, SES, sex, race, and past career experiences. Types of people could be identified who are apt to be satisfied or dissatisfied in certain science careers. It would be important to note whether specific groups such as women and minorities are more often dissatisfied with aspects of scientific work than white males.

The final step of such a research undertaking should be the integration of the results into a comprehensive set of policy recommendations for means of attracting potential scientists into science careers and reducing the grievances of those already in science careers. These recommendations would be the basis for a number of further studies that would investigate alternative means for change--for example, restructuring of jobs, better matches between jobs and people (better vocational counseling), and changes in expectations of what it is like to have a science job (more complete career education programs). Such changes would lead to the reduction of areas of dissatisfaction with science careers and ultimately result in a more effective development of our scientific talent.

REFERENCES

Astin, H. S. Career development during the high school years. Journal of Counseling Psychology, 1967, 14, 94-98.

Astin, H. S. Stability and change in the career plans of ninth grade girls. Personnel and Guidance Journal, 1968, 46, 961-966.

Astin, H. S. Personal and environmental factors in career decisions of young women. Final Report. Washington, D.C.: Bureau of Social Science Research, 1970.

Astin, A. W. Undergraduate institutions and the production of scientists. Science, 1963, 141, 334-338.

Cass, J., & Birnbaum, M. Comparative guide to American colleges. New York: Harper & Row, 1973.

Claudy, J. G., Gross, D. E., & Strause, R. A. Two population studies: Family size, birth order, and characteristics of young adults; and a study of married couples in Knox County, Tennessee. Palo Alto, California: American Institutes for Research, 1974.

Cooley, W. W. Career development of scientists. Cambridge, Mass.: Graduate School of Education, Harvard University, 1963.

Cooley, W. W. Predicting career plan changes. In J. C. Flanagan & W. W. Cooley (Eds.), Project TALENT: One-year follow-up studies. Pittsburgh: University of Pittsburgh, School of Education, 1966.

Cooley, W. W., & Lohnes, P. R. Project TALENT: Predicting development of young adults. Pittsburgh: American Institutes for Research and the School of Education, University of Pittsburgh, 1968.

Crane, D. Scientists at major and minor universities: A study of productivity and recognition. American Sociological Review, 1965, 30, 699-713.

Crosby, R. C., & Winsor, A. L. The validity of student estimates of their interests. Journal of Applied Psychology, 1941, 25, 408-414.

Davis, J. A. Great aspirations: The graduate school plans of America's college seniors. Chicago: Aldine Publishing Company, 1964.

Davis, J. A. Undergraduate career decisions: Correlates of occupational choice. Chicago: Aldine Publishing Company, 1965.

Eiduson, B. T. Psychological aspects of career choice and development in the research scientist. In Eiduson and Beckman (Eds.), Science as a career choice. New York: Russell Sage Foundation, 1973.

Finkel, M. Factors affecting the high school student's choice regarding a science career. Science Education, 1961, 45, 153-157.

Flanagan, J. C., & Cooley, W. W. Project TALENT: One-year follow-up studies. Pittsburgh: University of Pittsburgh, School of Education, 1966.

Flanagan, J. C., Dailey, J. T., Shaycoft, M. F., Gorham, W. A., Orr, D. B., & Goldberg, I. Design for a study of American youth. Boston: Houghton Mifflin, 1962.

Flanagan, J. C., Davis, F. B., Dailey, J. T., Shaycoft, M. F., Orr, D. B., Goldberg, I., & Neyman, C. A., Jr. The American high school student. Pittsburgh: University of Pittsburgh, 1964.

Flanagan, J. C., Tiedeman, D. V., Willis, M. B., & McLaughlin, D. H. The career data book: Results from Project TALENT's five-year follow-up study. Palo Alto, California: American Institutes for Research, 1973.

Harmon, L. R. National Academy of Sciences: Profile of PhDs in the sciences. OSP Publication 1293. Washington, D.C.: National Academy of Sciences, 1965.

Lee, E. C. A study of careers in science, mathematics and teaching. Unpublished report. Atlanta: Emory University, 1974.

Lehmann, I. J., & Nelson, C. H. Some characteristics of honors section students in natural science at a state university. Science Education, 1960, 44, 267-273.

Lohnes, P. R. Measuring adolescent personality. Pittsburgh: University of Pittsburgh, School of Education, Project TALENT, 1966.

McLaughlin, D. H. Interest inventory validity for vocational satisfaction. Paper presented at the meetings of the American Psychological Association, Chicago, September 1975.

Morrison, J. W. The vocational response of high school students to science courses. School Science and Mathematics, 1970, 70, 720-734.

Nordstrom, C., & Friedenberg, E. Z. Why successful students of the natural sciences abandon careers in science. Report No. CRP-787. New York: City University of New York, Brooklyn College, 1961.

O'Hara, R. P., & Tiedeman, D. V. Vocational self-concept in adolescence. Journal of Counseling Psychology, 1959, 6, 292-301.

Parrish, J. B. Women in professional training--an update. Monthly Labor Review, 1975, 98, 49-51.

Reid, J. W., Johnson, A. P., Entwisle, F. N., & Angers, W. P. A four-year study of the characteristics of engineering students. Personnel and Guidance Journal, 1962, 41, 38-43.

Rever, P. R. Scientific and technical careers: Factors influencing development during the educational years. Iowa City: ACT Publications, 1973.

Roose, K. D., & Andersen, C. J. A rating of graduate programs. Washington, D.C.: American Council on Education, 1970.

Rossi, R. J., Bartlett, W. B., Campbell, E. A., Wise, L. L., & McLaughlin, D. H. Using the TALENT profiles in counseling: A supplement to the career data book. Palo Alto, California: American Institutes for Research, 1975.

Shaycoft, M. F. Careers in science: A Project TALENT study. Palo Alto, California: American Institutes for Research, 1975.

Skypek, D. H. A study of factors which influence women and blacks in science career choice and stability. Progress Report: NSF Grant No. GY-11321. Atlanta, Georgia: Division of Educational Studies, Emory University, 1975.

Super, D. E. Psychological determinants of vocational choice. Paper presented at the meeting of the 5th World Congress of Educational and Vocational Guidance, Quebec, August 1973.

Super, D. E., Stanishevsky, R., Mathis, N., & Jordaan, J. P. Career development: Self-concept theory. Princeton, N.J.: College Entrance Examination Board, 1963.

Tarvis, C. The end of the IQ slump. Psychology Today, 1976, 9, 69-74.

Terman, L. M. Scientists and nonscientists in a group of 800 gifted men. Psychological Monographs, 1954, 68, (Whole No. 378).

Tuck, B. F. Self-evaluation and realism of vocational aspiration. New Zealand Journal of Educational Studies, 1972 (May), 30-37.

West, S. S. Class origins of scientists. Sociometry, 1961, 24, 251-269.

Williams, R. A. Personality characteristics of high-school curriculum groups. Unpublished master's thesis, University of Pittsburgh, 1967.

Wise, L. L., McLaughlin, D. H., Shaycoft, M. F., & Steel, L. J. The Project TALENT Data Bank handbook. Palo Alto, California: American Institutes for Research, 1976.

Yen, W. M., & McLaughlin, D. H. Post high school education and career development. Palo Alto, California: American Institutes for Research, 1974.

Zajonc, R. B. Birth order and intelligence: Dumber by the dozen. Psychology Today, 1975, 8, 37-43.

APPENDIX A

Selection of the 1975 Sample

The purpose of the sample selection was to obtain a set of high school students and environments that would be typical of high schools across the country while being close enough to the Palo Alto office of the American Institutes for Research that travel costs would be minimal. The sample was further designed to include adequate numbers of black and Spanish surname students for meaningful statistical comparisons, and an attempt was made to vary schools in the sample on a dimension of excellence of science teaching. As it turned out, it was not possible to control this dimension within the constraints applied by the other dimensions.

The sample was selected first by selecting schools and then by selecting students within schools to be representative of the school populations. Specifically, we planned to choose two schools within each of the following categories, one with "excellent" science education and the other with "average" science education, and then to select approximately 100 students in each school distributed across the three grades, 10th to 12th. The four categories of high schools were:

Inner City: A school with more than 50% ethnic minority, in a central city of more than 250,000 people, and with a low median yearly income. This type of school was intended to represent the many schools in disadvantaged urban centers across the country.

Outer City: A school with fewer than 50% of any ethnic minority, in a city classified by the census as a central city but with less than 250,000 population, and not a suburb of a larger city or metropolitan area. This type of school was intended to represent the many schools typical of "middle America," with none of the problems of either inner city schools or rural schools.

Suburban: A school with fewer than 50% of any ethnic minority, in a town of between 10,000 and 50,000 people in the fringe of a metropolitan area whose central city has more than 250,000 people, and where the citizens of the town have a high median yearly family income. This type of school was intended to represent the affluent suburbs across the country.

Rural: A school in a community of less than 2,500 people, not adjacent to a large metropolitan area, representative of such schools across the country.

The public high schools within 125 miles of Palo Alto, California, were located in Patterson's American Education 1974. The urban status of the communities containing the schools was obtained from the U.S. Census Bureau, the 1970 census. The information on median income was obtained from a California State Department of Education publication entitled California Testing Program 1971-72 & 1972-73 (1974). The information on ethnic minority percentages was also obtained through the California State Department of Education, based on annual reports submitted by local school districts.

Several measures of science teaching were collected; however, because of the small number of possible schools in some categories and the lack of great variation on these measures within the four categories compared to variation between them (and due to delay in receiving some of the information), the information collected was not used. As a matter of record, however, we present here an outline of that attempt. (1) Data were collected from the Westinghouse Science Talent Search on the number of students from each high school who were entrants and honors group members in the period from 1960 to 1974. (2) Data were collected on the number of students majoring in science on campuses of the University of California, by high school. (3) Data were collected from the National Science Teachers Association on the high schools that subscribed to their publications Science and Children, Science Teacher, or Journal of College Science. (4) Data were collected on the participation of teachers at the high schools in Summer Science Institutes for Secondary School Teachers sponsored by the National Science Foundation.

The design called for eight schools, two in each type of community. The final sample of eleven schools was the result of two alterations in the design. One school had only 11th and 12th grades and another school in the same area was chosen to obtain comparable 10th graders. After seven of the eight cells were filled, one school district decided not to participate and in a replacement district local administrators wished to have three of their schools participate rather than one.

The distribution of the final sample of schools on various dimensions is shown in Table A-1.

The students were not chosen randomly within schools, nor were they chosen as representative of the best science students. The selection procedures, which differed somewhat from school to school, were the result of compromise between our need for a sample representative of typical students and the school's desire for a minimum of disruption. Indeed, the procedures were designed so that the total experience would be a valuable career guidance lesson for the participating students.

Because the primary purpose of the sample selection was to achieve qualitative representation of the diversity of schools in America, not to evaluate the science education programs in these schools, it was not deemed important to attempt to achieve truly random samples. Selection of students in required nonscience courses was adequate for our purposes, although the cases where the course was a career education course or subjects were volunteers may have introduced some bias. Parental permission was required for participation; however this did not eliminate any students.

Table A-1

School District Median Income, a Measure of Science Productivity, and Student Selection Rules for This Project, for Each School

School	Classification	School District Median Income	School District Per Pupil Expenditure	Student Selection Rules for This Project
1	Suburban	$11,486	$700	Required (nonscience) courses[a]
2	Suburban	13,514	878	Random (every tenth student)
3	Rural	9,602	632	Required (nonscience) courses
4	Rural	10,034	891	Required (nonscience) courses
5	Outer urban	9,646	733	Required (nonscience) courses
6	Inner urban	11,905	774	Required (nonscience) courses
7	Outer urban	11,405	899	Required (nonscience) courses
8	Inner urban	11,905	774	Career education course
9	Inner urban	12,033	712	Required (nonscience) courses
10	Inner urban	12,033	712	Required (nonscience) courses
11	Suburban	12,033	712	Required (nonscience) courses and advanced English

[a]English, social studies, or physical education.

APPENDIX B

Correlations Among Selected Variables from Project TALENT

An essential aspect of this project was the search for nonability factors that were correlated with science career development. These are factors that high school students could take into account in career planning. The search for factors included both the calculation of partial correlations, partialing out Scientific Potential, and the calculation of multiple linear regression coefficients.

In preparing for the regression analyses using nonability variables from Project TALENT (see Appendix C), we selected a subset of the 400 variables used in the partial correlational analyses (see Section 4.1). The selected variables consisted primarily of the items or scales with the largest correlations with having a science occupation after partialing out Scientific Potential. If an item had a significant partial correlation for at least one sex it was included, but an effort was made to choose only one representative variable when several were similar and highly intercorrelated. To these variables were added several others that did not have large partial correlations with science occupations but are of theoretical importance, such as the number of science courses taken, SES, whether the student's father had a science occupation, whether the student's mother was a professional, and the amount of father's and mother's education.

A total of 37 variables were selected for the regression analyses in addition to Scientific Potential, science career plans, and later science occupation. The critical intercorrelations between these 40 variables are listed in Table B-1. The correlations of each variable with Scientific Potential, with science career plans, with science occupation, and its partial correlation with science occupation controlling for Scientific Potential, are listed separately by sex. The first nine variables are family background variables, while the remainder reflect interests, activities, plans, and opinions during the high school years. Variables have been rank ordered according to the size of their partial correlations.

160

Table B-1

Correlations of a Subset of Project TALENT Nonability Variables with Scientific Potential, Science Career Plans, and Science Occupation, Separate by Sex

Variable	Correlation with Scientific Potential		Correlation with Science Career Plans	
	M	F	M	F
Family Background Variables				
Subscribe to many farm magazines at home	-.20*	-.20*	-.05	.01
Total income of household	.14*	.22*	.08	.06
Subscribe to many opinion magazines at home	.06	.13*	.02	.15*
Amount of education parents desire for student	.45*	.33*	.26*	.17*
Amount of father's education	.36*	.44*	.13*	.20*
Amount of mother's education	.34*	.37*	.08	.15*
Socioeconomic status of family (SES)	.44*	.47*	.13*	.11*
Mother is a professional	.11*	.11*	.07	.08
Father is employed in science	.08	.14*	.10	.03
High School Variables				
Expected amount of education	.57*	.52*	.34*	.21*
High grades in all courses	.37*	.29*	.24*	.24*
Good study habits and attitudes	.40*	.31*	.23*	.12*
Saving money primarily for college	.35*	.32*	.25*	.11*
Enrolled in college preparatory program	.57*	.51*	.33*	.17*
Often discussed college plans with school counselor	.23*	.20*	.07	.14*
Expect college expenses to be covered by scholarships	.04	.10	.15*	.06
Enjoy learning	.09	.19*	.17*	.21*
Took National Merit Scholarship tests	.47*	.45*	.32*	.03
College degree necessary for my work	.46*	.36*	.40*	.22*
Interest in biological science and medicine	.25*	.26*	.35*	.25*
High minimum acceptable income	.08	.00	.04	.15*
Read science non-fiction books	.14*	.05	.17*	.04
Estimated cost of college	.37*	.21*	.14*	.17*
Rarely absent from school	.11*	.09	.08	.07
Expected amount of education by peers	.49*	.29*	[illegible]	.12*
Number of foreign language courses taken	.44*	.56*	.16*	.12*
Interest in physical science and math	.46*	.36*	.44*	.31*
Number of math courses taken	.63*	.62*	.30*	.20*
Able to concentrate while reading	.25*	.16*	.22*	.03
Read political and historical books	.18*	.19*	.06	.03
Would borrow a lot of money to attend college	.28*	.25*	.22*	.16*
Active in school subject matter clubs	.13*	.17*	.22*	.03
More trained women are needed in this country	.02	.12*	-.03	.07
Number of science courses taken	.48*	.20*	.27*	.18*
Interest in labor	-.31*	-.07	-.15*	-.04
Amount of work activities (chores and jobs)	-.15*	-.02	-.09	-.08
Interest in office work	-.15*	-.31*	-.11*	-.17*
Dependent Variables				
Scientific Potential	1.00	1.00	.37*	.21*
Science career plans	.37*	.21*	1.00	1.00
Science occupation 11 years after high school	.41*	.18*	.33*	.23*

161

Table B-1--continued

Variable	Correlation with Science Occupation M	Correlation with Science Occupation F	Partial Correlation with Science Occupation, Controlling for Scientific Potential M	Partial Correlation with Science Occupation, Controlling for Scientific Potential F
Family Background Variables				
Subscribe to many farm magazines at home	-.07	.08	.01	.13*
Total income of household	.13*	.16*	.09	.12*
Subscribe to many opinion magazines at home	.01	.13*	.01	.11*
Amount of education parents desire for student	.27*	.15*	.10	.09
Amount of father's education	.23*	.10	.09	.02
Amount of mother's education	.21*	.15*	.08	.09
Socioeconomic status of family (SES)	.25*	.12*	.09	.04
Mother is a professional	.09	.09	.05	.08
Father is employed in science	.04	.07	.03	.05
High School Variables				
Expected amount of education	.39*	.20*	.21*	.13*
High grades in all courses	.31*	.13*	.19*	.08
Good study habits and attitudes	.32*	.13*	.19*	.08
Saving money primarily for college	.29*	.16*	.17*	.11*
Enrolled in college preparatory program	.36*	.19*	.16*	.11*
Often discussed college plans with school counselor	.18*	.19*	.09	.16*
Expect college expenses to be covered by scholarships	.06	.18*	.04	.16*
Enjoy learning	.17*	.09	.15*	.06
Took National Merit Scholarship tests	.31*	.14*	.15*	.06
College degree necessary for my work	.30*	.17*	.14*	.11*
Interest in biological science and medicine	.23*	.10	.14*	.05
High minimum acceptable income	.01	.13*	-.02	.14*
Read science non-fiction books	.11*	.14*	.06	.13*
Estimated cost of college	.26*	.08	.13*	.04
Rarely absent from school	.16*	.03	.13*	.02
Expected amount of education by peers	.30*	.15*	.12*	.11*
Number of foreign language courses taken	.28*	.19*	.12*	.11*
Interest in physical science and math	.28*	.16*	.12*	.10
Number of math courses taken	.34*	.17*	.12*	.07
Able to concentrate while reading	.21*	.06	.12*	.03
Read political and historical books	.09	.15*	.02	.12*
Would borrow a lot of money to attend college	.21*	.15*	.11*	.11*
Active in school subject matter clubs	.11*	.14*	.07	.11*
More trained women are needed in this country	.05	.13*	.04	.11*
Number of science courses taken	.27*	.08	.09	.04
Interest in labor	-.22*	-.08	-.11*	-.06
Amount of work activities (chores and jobs)	-.17*	-.06	-.12*	-.05
Interest in office work	-.10	-.20*	-.04	-.15*
Dependent Variables				
Scientific Potential	.41*	.18*	--	--
Science career plans	.33*	.23*	.21*	.20*
Science occupation 11 years after high school	1.00	1.00	--	--

*Correlation significant at the .01 level (2-tailed test)

Note: For males, the raw N = 4,166 and the effective N = 565; for females, the raw N = 3,821 and the effective N = 533.

APPENDIX C

Regression Analyses of Selected Variables from Project TALENT

In order to achieve a more holistic picture of which nonability variables in high school were most predictive of who entered science, we regressed both career plans in high school and occupation 11 years after high school on a selected subset of 37 variables in addition to Scientific Potential. The correlations of these variables with Scientific Potential, science career plans, and science occupations 12 years later, as well as the partial correlations with science occupations controlling for Scientific Potential, are listed in Appendix B.

Table C-1 presents the results of the linear regression analyses that are described in more detail in the remainder of this appendix. The samples of TALENT participants examined in the various regressions were defined on the basis of sex and science-nonscience career plans in high school in 1960. The criterion variable was either science vs. nonscience career plans in high school or science vs. nonscience occupation 12 years later. The correlations of the predictor variables with the criterion variables for the samples of all males and all females can be found in Table B-1; the correlations were sometimes quite different in the subsamples defined by career plans. Each of these regressions was performed twice, once with Scientific Potential as a predictor variable and once without. Because the inclusion of Scientific Potential had little or no effect on the rank ordering of the other variables by beta weight, the results are displayed only from the regression runs that included Scientific Potential.

Table C-2 displays the ten variables with the largest beta weights when regressed against high school science career plans for all males in the 11th grade in 1960. Whether or not Scientific Potential was included, 35% of the variance could be accounted for in the career plans of high school males. Male students with science career plans, besides being interested in physical and biological science, but not in office work, realized that a college degree was necessary for the kind of work they wanted to do; many had taken the National Merit Scholarship tests as a step toward their careers; furthermore, they tended to possess high Scientific Potential.

163

Table C-1

Linear Regression Analyses onto Science/Nonscience Career and Science/Nonscience Occupation, Based on TALENT Dat

Sample	M-All[b]	M-All	M-Sci	M-Nonsci	F
Raw N	4,166	4,166	1,003	3,163	1
Effective N[a]	565	565	215	350	
Criterion variable	Plans	Occup	Occup	Occup	P
Variable			Beta Weight		
Family Background					
Subscribe to many farm magazines at home	.010	.042	.021	.056	
Total income of household	.027	.036	.027	.048	-
Subscribe to many opinion magazines at home	.013	-.035	-.000	-.066	
Amount of education parents desire for student	.034	-.011	.028	-.060	
Amount of father's education	.040	.065	-.028	.138*	
Amount of mother's education	-.077*	.018	.083	-.082*	
Socioeconomic status of family (SES)	-.075*	-.014	.017	-.096	-
Mother is a professional	.048	.016	-.014	-.021	-
Father is employed in science	.031	.003	.013	-.030	-
High School					
Expected amount of education	-.017	.012	.051	.048	-
High grades in all courses	.011	.118*	.122*	.094*	
Good study habits and attitudes	-.010	.051	.095*	.058	
Saving money primarily for college	.042	.073*	.128*	.027	-
Enrolled in college preparatory program	.036	.044	-.033	.136*	-
Often discussed college plans with school counselor	-.044	.015	.059	-.056	
Expect college expenses to be covered by scholarships	.036	-.019	-.051	-.016	
Enjoy learning	-.017	.038	.038	.052	
Took National Merit Scholarship tests	.111*	.075*	.047	.049	-
College degree necessary for my work	.184*	-.018	-.034	.000	
Interest in biological science and medicine	.115*	.068*	.019	.160*	
High minimum acceptable income	-.001	-.091*	-.199*	-.020	
Read science non-fiction books	.016	.010	-.078	.061	-
Estimated cost of college	-.043	.091*	-.006	.187*	
Rarely absent from school	-.013	.086*	.087	.069	-
Expected amount of education by peers	-.056	.038	.034	.062	-
Number of foreign language courses taken	-.025	.017	.110*	-.101*	-
Interest in physical science and math	.250*	.026	.004	-.077	
Number of math courses taken	-.050	.035	-.007	.131*	
Able to concentrate while reading	.081*	.021	-.095*	.087*	-
Read political and historical books	-.060	-.015	.127*	-.104*	-.
Would borrow a lot of money to attend college	.046	-.016	.004	-.053	
Active in school subject matter clubs	.080*	-.004	-.031	-.079	-.
More trained women are needed in this country	-.044	.007	-.012	.044	-.
Number of science courses taken	.035	.008	.017	-.025	
Interest in labor	.024	-.015	.078	-.037	-.
Amount of work activities (chores and jobs)	-.006	-.080*	-.127*	.002	-.
Interest in office work	-.191*	-.074*	-.151*	.014	-.
Scientific Potential	.103*	.094*	.149*	.004	
Dependent Variables					
Science career plans	CV	--	--	--	
Science occupation 11 years after high school	--	CV	CV	CV	
Multiple R	.595	.538	.576	.484	

[a]See page 31 for a discussion of effective Ns.

[b]M-All and F-All are the entire populations of males and females in this sample; M-Sci and M-Nons males with science and with nonscience career plans; Plans stands for science vs. nonscience ca high school, and Occup stands for science vs. nonscience occupation 12 years later; CV is crite

*Ten beta weights with the largest absolute values in each regression analysis.

Table C-2

The 10 Variables with the Largest Linear Contributions to High School Science Career Plans for All Males

Beta Weight	Variable
.250	Interest in physical science
-.191	Interest in office work
.184	College degree necessary for my work
.115	Interest in biological science
.111	Took National Merit Scholarship tests
.103	SCIENTIFIC POTENTIAL
.081	Can concentrate while reading
.080	Active in academically-oriented school clubs
-.077[a]	Amount of mother's education
-.075[a]	SES

Note. Independent variables accounted for 35.4% of the variance (R=.60). When Scientific Potential was not included, the remaining variables accounted for 35.1% of the variance. Raw N = 4,166 and effective N = 565.

[a]Beta weight has the opposite sign from the zero-order correlation between this variable and the criterion variable in this population.

Table C-3 displays the variables with the largest contributions to the prediction of whether male students would have a science occupation 11 years after high school. The inclusion of career plans as one of the variables, when predicting the type of occupation the student would have later, increased the amount of variance accounted for by only 1.5%. Adding career plans to the equation did not greatly reduce the relative contribution of any of the other variables, although it then had the largest beta weight. When career plans were not included, 29% of the variance could be accounted for. This was almost as large a proportion of the variance as could be accounted for in science vs. nonscience high school career plans (35%), which is surprising since in this case the same variables assessed in high school were being used to predict science vs. nonscience occupation 12 years later.

Table C-3

The 10 Variables with the Largest Linear Contributions to Science Occupation 11 Years after High School for All Males

Beta Weight	Variable
.118	High grades
.094	SCIENTIFIC POTENTIAL
.091	Estimated cost of college
.091[a]	Minimum acceptable income
.086	Rarely absent from school
-.080	Work activities (chores and jobs)
.075	Took National Merit Scholarship tests
-.074	Interest in office work
.073	Saving money primarily for college
.068	Interest in biological science

Note. Career plans were not included as an independent variable.

Note. Independent variables accounted for 28.9% of the variance (R=.54). When Scientific Potential was not included, the remaining variables accounted for 28.6% of the variance. Raw N = 4,166 and effective N = 565.

[a]Beta weight has the opposite sign from the zero-order order correlation between this variable and the criterion variable in this population.

Later regressions were performed separately for males with science career plans and for males with nonscience career plans. The pattern of variables predictive of entering a science career appeared quite different for the two groups. Actually this was not entirely unexpected, as in one case we were trying to determine which science students would persist in their plans, while in the other case we were trying to determine what kind of student who was not planning a science career would change his mind and acquire the needed scientific training. In the former instance students had already developed strong interests in science, but many may have been eliminated on the basis of their abilities and persistence, while in the latter instance students had shown more interest in fields other than science, but those who later switched into science must have maintained enough interest in and exposure to science so as not to preclude a science career. Because the analyses of these two groups of males with science or nonscience career plans produced such different results, the patterns displayed in Table C-3 for all males must be a combination that may not be an accurate representation of either group. Rather than describe the results for all males, therefore, we will go on to the analyses of the two subpopulations.

Table C-4 shows the variables with the largest beta weights for males with science career plans in high school. The most important single variable was the minimum acceptable income 20 years after high school. While this variable had a nonsignificant positive correlation with entering science when all the males were considered, it had a negative correlation for those males who already had science career plans; minimum acceptable income had a positive correlation with science careers for females. It appears that females who expected a high income were more likely to go into science, but that males with science career plans were more likely to persist in them if they did not expect a high income. The women's results were probably due to those planning to be housewives responding that they expected no income, and therefore the mean acceptable minimum income of all career women including those going into science would be higher than the population mean for females. The results for men may reflect that some became disillusioned and switched career plans when they learned that they had overestimated the salaries of many science occupations, or that the competition was greatest for the most lucrative science careers (e.g., physician).

The male "persisters" tended to have high Scientific Potential and particularly little interest in office work. They were saving money primarily to go to college, but they did not have part-time jobs or extensive chores after school or on weekends. They had good study habits and attitudes, read political and historical books, and received high grades.

The regression for males with nonscience career plans in high school, Table C-5, shows a very different picture. These males, who at some point after 11th grade changed their career plans and entered a science career,

Table C-4

The 10 Variables with the Largest Linear Contributions to Science Occupation 11 Years after High School for Males with Science Career Plans

Beta Weight	Variable
-.199	Minimum acceptable income
-.151	Interest in office work
.149	SCIENTIFIC POTENTIAL
.128	Saving money primarily for college
.127	Read political and historical books
-.127	Work activities (chores and jobs)
.122	High grades
.110	Number of foreign language courses taken
.095	Good study habits and attitudes
-.095[a]	Can concentrate while reading

Note. Independent variables accounted for 33.2% of the variance (R=.58). When Scientific Potential was not included, the remaining variables accounted for 32.5% of the variance. Raw N = 1,003 and effective N = 215.

[a]Beta weight has the opposite sign from the zero-order correlation between this variable and the criterion variable in this population.

were characterized by having been in a college preparatory program in high school and having planned to attend an expensive college. Thus, their educational aspirations were not incompatible with preparation for a science career.

The males who switched into science tended to have higher interest in biological and medical fields than their nonscience peers. While most females were interested in biology and medicine but interest in the physical sciences and mathematics was a better predictor of a later science career for them, the converse was true of males: they tended to have high levels of interest in the physical sciences and mathematics, but interest in biology was a better predictor of switching into a science career.

Table C-5

The 10 Variables with the Largest Linear Contributions to Science Occupation 11 Years after High School for Males with Nonscience Career Plans

Beta Weight	Variable
.187	Estimated cost of college
.160	Interest in biological science
.138	Amount of father's education
.136	Enrolled in college preparatory program
.131	Number of math courses taken
-.104	Read political and historical books
-.101[a]	Number of foreign language courses taken
.094	High grades
.087	Can concentrate while reading
-.082[a]	Amount of mother's education

Note. Independent variables accounted for 23.4% of the variance (R=.48). Just as much of the variance was accounted for without Scientific Potential. Raw N = 3,163 and effective N = 350.

[a]Beta weight has the opposite sign from the zero-order correlation between this variable and the criterion variable in this population.

Among the variables with large beta weights were two with beta weights that had the opposite sign of their zero-order correlations with entering a science career: number of foreign language courses taken and the amount of mother's education. These variables were acting as suppressor variables, that is, they were moderating the effects of one or more other variables with which they were correlated. This indicates that the pattern or relationship between these variables was more important in prediction than their independent values. The first of these patterns was the amount of father's education minus the amount of mother's education, or the difference between them. The second pattern was the number of math courses taken minus the number of foreign language courses taken; thus, the content of these students' educational development was also compatible with science career preparation. Both of these differences between pairs of variables were typical of males who switched into science after 11th grade.

It was not surprising that the pattern of having taken more math courses than foreign language courses was predictive of entering a science career, as this was in agreement with earlier findings (e.g., Cooley, 1963). Both the number of high school math courses and language courses were predictive of going to college, as were many of the other variables with large beta weights. But the students who took more math than foreign language in high school were more likely to major in science in college in spite of their nonscience career plan in high school, while the students who took more foreign language than math were more likely to major in one of the humanities in college. Given that other variables in the regression run (such as being in a college preparatory program and planning to attend an expensive college) were already differentiating between college-bound and noncollege students, the pattern of more math courses than foreign language courses in high school differentiated between the science majors and the humanities majors in college.

It should be noted that Scientific Potential was not an important variable for predicting who would switch into science, although it was important for predicting who would persist in his science career plans. These results indicate that for males who were actively interested in working in science, abilities may have determined who dropped out and who succeeded, while for males who were not considering science careers, other motivational, background, and exposure factors appeared more important than abilities in determining who would later enter a science career.

Turning now to the science career plans of female high school students, the results of the regression are displayed in Table C-6. As might be expected, the females who had science career plans were interested in physical science, had high grades, believed that a college degree was necessary for the kind of work they wanted to do, and had discussed their college plans with the school counselor. There was an interesting pattern among three highly intercorrelated family background variables: amount of father's education, amount of mother's education, and SES (which was based on parents' education among other variables). The first two had positive beta weights and SES had a negative beta weight, although all three had positive zero-order correlations with science career plans. The crucial pattern for these females was having parents who were better educated than would have been expected from the other indicators of socioeconomic status--that is, when converted to z-scores, parents' education minus SES was greater than for their peers. In other words, the female science students tended to have highly educated but not wealthy parents.

Table C-6

The 10 Variables with the Largest Linear Contributions to High School Science Career Plans for All Females

Beta Weight	Variable
.230	Interest in physical science
.149	Amount of father's education
-.135[a]	Took National Merit Scholarship tests
.128	High grades
.127	College degree necessary for my work
-.110[a]	SES
.100	Often discussed college plans with school counselor
.095	Amount of mother's education
.088	Number of math courses taken
-.087	Interest in office work

Note. Independent variables accounted for 23.3% of the variance (R=.48). Just as much of the variance was accounted for without Scientific Potential. Raw N = 3,821 and effective N = 533.

[a]Beta weight has the opposite sign from the zero-order correlation between this variable and the criterion variable in this population.

There were two ways in which the various regressions for females were strikingly different from the equivalent regressions for males. First, the effect of family environment, independent of its effect on abilities, seemed more important for the females in determining both career plans and later occupations. Second, Scientific Potential was not a crucial variable in any of the female regression analyses; it was not among the 10 variables, or even 20 variables, with the largest beta weights. Characteristics other than abilities appeared to be much more important when women considered whether or not to work in science. Although the average female did not score much lower on our Scientific Potential function than the average male (see Section 4.2), she was much less likely than he to plan to enter a science career (31.8% vs. 5.4%), and even less likely to have a science occupation 12 years later (5.5% vs. 0.8%), as displayed in Figure C-1 (see also Sect? ` 4.8). In addition, the women who did go into science had not closed the ability gap between themselves and their male peers in science as would have been expected if only the most able women prepared for and accepted science occupations. It appears that women in science were *not* an extremely select group in terms of science abilities (although much more able than the average), and that other noncognitive factors were more influential for them than for men. For males, more than for females, high Scientific Potential was likely to provide the basis for pursuing a science career.

The results of the regression analyses for females with science occupation as the dependent variable are summarized in Table C-7. Because of the small percentage of women in science 11 years after high school (0.8%), we did not attempt to analyze separately the subpopulations of those with and those without science career plans in high school; had we been able to analyze the subgroups separately, we expect that we would have found major differences in the patterns of variables predictive of establishing a career in science.

Women who ended up in science displayed the pattern of being relatively more interested in the physical sciences than in biological sciences compared to their female peers (a positive beta weight for the former and a negative beta weight for the latter), in spite of the fact that more of them ended up in the biological sciences than in the physical sciences. They were less interested in office work; high school females are generally more interested in office work than males (this was still true of high school students in 1975), but women with high Scientific Potential who were also interested in office work were less likely to establish science careers. Women who did establish science careers believed that women should go to college because more trained women are needed in this country.

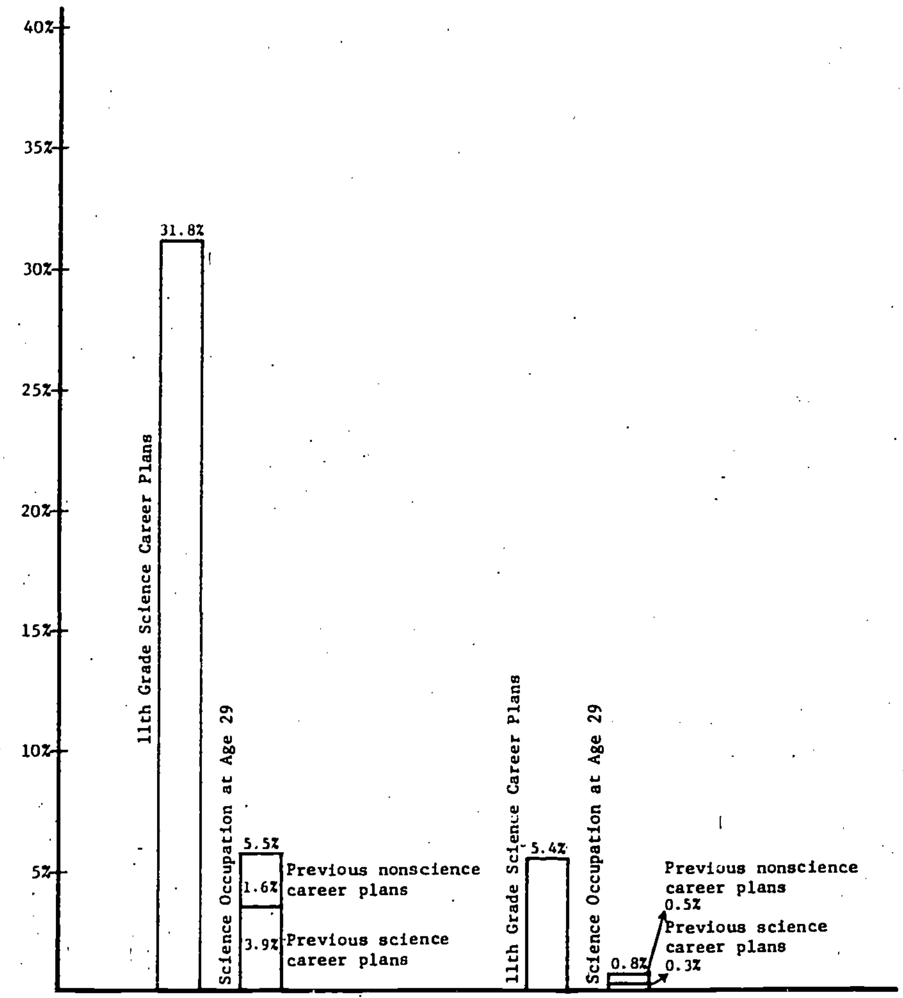


Figure C-1. Percentages of male and female TALENT participants with science career plans in 1960 and a science occupation 12 years later.

SES entered the regression function as a suppressor variable (i.e., with a beta weight that had the opposite sign of its zero-order correlation with the criterion variable). Women in science tended to come from homes where the total income from all the members of the household was higher than would be expected from the general SES of the family, that is, when converted to z-scores, total income minus SES was greater than for their peers. It may have been that their total family income was high because often their mothers and older siblings had jobs and because in their homes more emphasis was placed on the work ethic and on having a worthwhile career.

Table C-7

The 10 Variables with the Largest Linear Contributions to Science Occupation 11 Years after High School for All Females

Beta Weight	Variable
.189	Total income of household
.183	Interest in physical science
-.137	Interest in office work
-.115[a]	Interest in biological science
.113	More trained women are needed in this country
-.112[a]	SES
.091	Often discussed college plans with school counselor
.085	Expect college expenses to be covered by scholarships
-.084[a]	Estimated cost of college
.075	Subscribe to many farm magazines at home

Note. Independent variables accounted for 16.9% of the variance (R=.41). When Scientific Potential was not included, the remaining variables accounted for 16.8% of the variance. Raw N = 3,821 and effective N = 533.

[a]Beta weight has the opposite sign from the zero-order correlation between this variable and the criterion variable in this population.

One final note on the results of these regressions: all regressions were performed in pairs, with and without Scientific Potential as one of the independent variables, and in every case almost as much variance could be accounted for without Scientific Potential as with it. Scientific Potential had 96%-100% of its explained variance in common with the other variables, in spite of the fact that the other variables were generally selected for having high correlations with the criterion variable after partialing out Scientific Potential! (The correlations of the other variables with Scientific Potential are listed in Appendix B, Table B-1.) This indicates that a few dozen of the right biographical questions could have given us as good an indication of whether a student would succeed in science as could dozens of ability tests administered over many hours at great inconvenience to the student. Why do we not dispense with the ability tests and instead use only the results of a biographical inventory when advising students whether or not to develop a science career plan? Unfortunately, there are two problems with using the biographical variables alone. First, when it is important to them to do so, such as when applying for admission to a science program, students can easily fake "high scores" when describing their interests and activities. Unless the student is being entirely honest; it is more reliable to use ability tests and verifiable background and activities information than to rely on the student's self-report.

Second, and more importantly, while we expect that the abilities needed to succeed in science will be much the same across various groups in our population and over long periods of time, the same cannot be said for the family background variables. These variables may reflect relationships that exist now but that we would not want to perpetuate in the future, or they may reflect relationships that hold for the majority of scientists, white males, but are inaccurate and misleading for various minority groups, and even for some nonminority individuals. We will want to be very careful, when noncognitive information about students is used to advise them about which careers would be appropriate for them, that in the process we are not inadvertently perpetuating the status quo. The primary purpose for analyzing the nonability variables as we have done is to discover what kinds of exposure, activities, and opportunities have been crucial to success in science in the past, so that this information can be used by students when making career development decisions.

APPENDIX D

The Career Planning Survey Results

The Career Planning Survey was designed as part of the Science Career Development Project and was administered to students from 11 high schools in California. The results from this questionnaire and from a battery of interest, knowledge, and ability tests given to the same students have been referred to as "the 1975 data" throughout this report. A total of 1,142 students comprised the 1975 sample.

The Career Planning Survey is reproduced in full on the following pages. The cover design was the winning entry to a contest we sponsored in the art classes of one of the pilot high schools; first, second, and third place entries received nominal monetary awards.

Information about the numbers of students who made each available response and their crucial characteristics has been placed next to most of the questions. This information is in the form of four numbers for each possible response: the first is the number of students who made that response; the second number is the percentage of the students who chose the response who had expressed science career plans; the third number is the mean Scientific Potential for the students who made the response and had nonscience career plans; the fourth number is the mean Scientific Potential of the students with science career plans. Scientific Potential has a mean of 50 and a standard deviation of 10.

For example, under sex is printed:

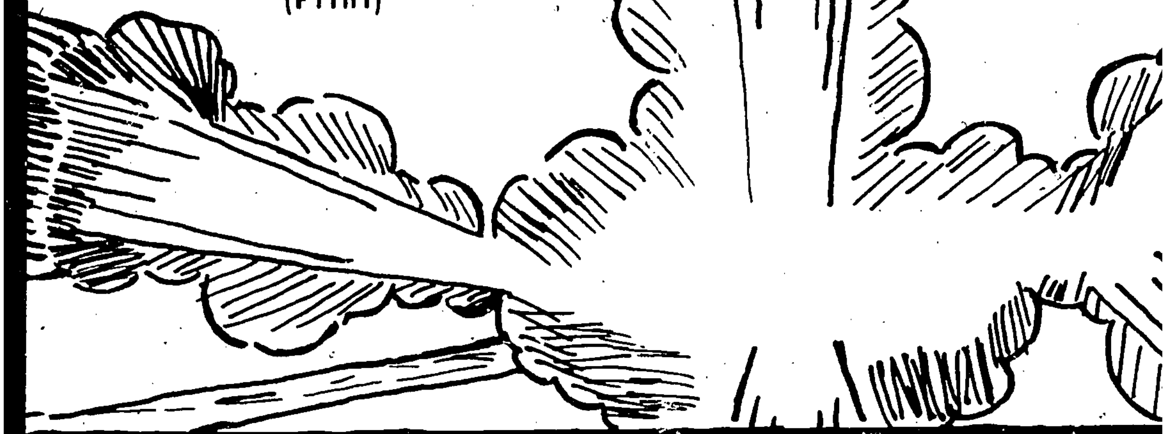
465	17	48	56	Female
415	24	50	59	Male

This translates as follows: 465 students identified themselves as females and 415 as males; 17% of the females and 24% of the males had science career plans--the remainder had nonscience career plans; females with nonscience career plans had a mean Scientific Potential of 48, while those with science career plans had a mean Scientific Potential of 56; the comparable means for males with nonscience and science career plans were 50 and 59.

Only cases with valid scores on Scientific Potential, with expressed career plans, and with valid responses to a question are included in the statistics printed for that question. For this reason the number of responses listed for a question is less than the total sample size of 1,142.

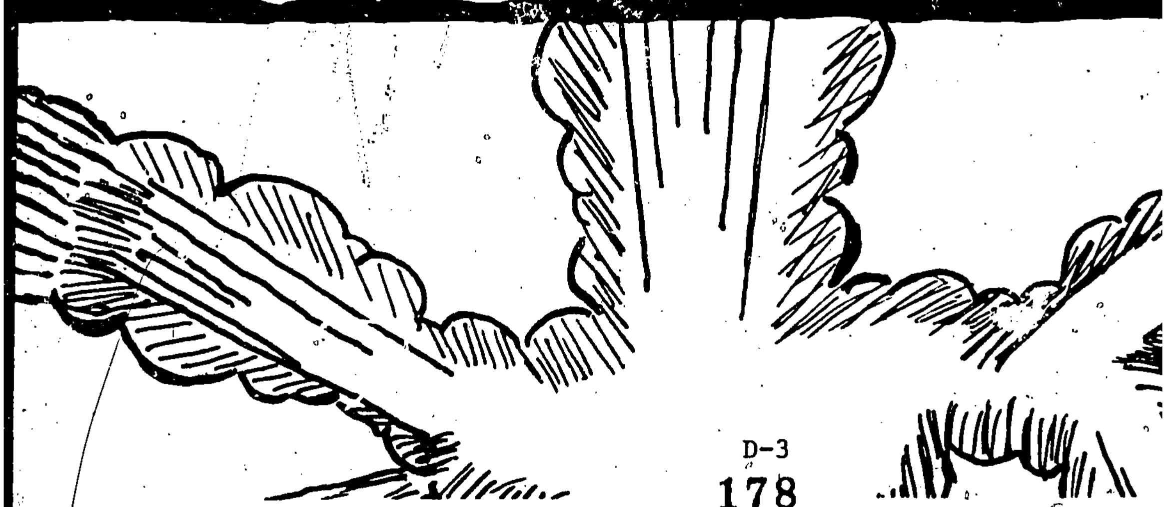
me: ________________________________
(Print)

OMB
Approval E



CAREER PLANNING SU

National Science Foundation
and
American Institutes for Resear



Your name ______________________________

Date of birth ______________
month/day/year

School ______________________________ Grade

10th	399	17	47	55
11th	262	23	47	58
12th	194	23	55	61

IMPORTANT — PLEASE READ

If there is a question you feel you don't want to answer, mark it with an "X." This is not a test so you will not be penalized for marking some questions in this way.

Your answers in this booklet are important because they will help us find out what high school students in many parts of California are thinking about in terms of their future careers. What you say will be kept in strict confidence--no one will see your answers but members of our research staff. Feel free to say what you want but take the time to read over each question carefully.

How long have you been a student at this school?

1 yr. or less	223	19	47	55
1-2 yrs.	321	18	47	55
2-3 yrs.	223	23	51	62
3-4 yrs.	67	25	56	62

If you are a new student, from which school and city did you come?

______________________ school / city ______________________

Check the appropriate boxes:

Sex

465 17 48 56 Female
415 24 50 59 Male

Ethnic Group

18 6 43 41 American Indian
92 14 39 47 Black/Negro
41 29 54 63 Oriental
164 15 40 47 Spanish surname (Chicano, Mexican-American, Puerto Rican, or Cuban)
509 23 53 61 White/Caucasian/Anglo
37 27 47 53 Other

Number of Brothers and Sisters

34 15 54 61 0
517 24 51 59 1-3
209 17 56 54 4-7
60 12 40 5? more than 7

Religion

321 18 47 53 Catholic
28 36 59 65 Jewish
195 21 54 62 Protestant
183 23 47 58 Other ______________________ please specify
110 15 49 59 None

Father's Highest Level of Education (check the circle):

◯ Junior High School 82 16 40 47 ◯ High School 311 14 45 53 ◯ College 497 28 55 61

Did he graduate? Yes 547 23 52 60 No 223 16 45 52 Don't know 20 10 43 48

Name of college ______________________

Mother's Highest Level of Education (check the circle):

◯ Junior High School 72 15 40 49 ◯ High School 403 15 47 56 ◯ College 336 29 55 60

Did she graduate? Yes 542 22 50 59 No 233 20 47 56 Don't know 19 11 45 60

Name of college ______________________

Father's (or male guardian's) occupation:

Nonscience	514	19	48	57
Science	81	41	61	63

Mother's (or female guardian's) occupation:

Nonscience	612	21	49	58
Science	15	27	47	52

What other job, of any in the world, do you think your father (or male guardian) would have liked most for himself?

Nonscience	66	21	52	64
Science	21	33	61	62

What other job, of any in the world, do you think your mother (or female guardian) would have liked most for herself?

Nonscience	80	24	52	59
Science	3	33	71	72

THINKING ABOUT CAREERS

Fill-in blanks and check the circles:

1. What job do you expect to have when you are 20 years old?

Nonscience	698	17	49	59
Science	33	91	55	55

   ______________________ (name of job)

   Pretty Sure ○ 548 19 49 58 Not Sure ○ 280 20 49 56

2. What job do you expect to have when you are 30 years old?*

Nonscience	628	0	49	--
Science	169	100	--	58

   ______________________ (name of job)

   Pretty Sure ○ 523 21 48 57 Not Sure ○ 288 20 50 60

3. What job, of any in the world, would you most like to have?

Nonscience	558	7	49	56
Science	158	71	53	58

   ______________________ (name of job)

   Pretty Sure ○ 533 20 49 [illegible] Not Sure ○ 172 22 49 61

4. One word which best describes the kind of person in the job you expect to have at 30 is

   ____

5. What person, book, or other source has most influenced this choice?

   ____

6. What do you feel will be the biggest problem you will have in getting this job?

   ____

____

*This question is the criterion variable for science-nonscience career plans.

7. How sure are you of your career plans? (Mark one)

- ◯ Completely sure
- ◯ Very sure
- ◯ Fairly sure
- ◯ Fairly unsure
- ◯ Very unsure

Completely sure	100	21	45	57
Very sure	198	23	47	58
Fairly sure	392	20	49	56
Fairly unsure	129	14	53	63
Very unsure	49	16	53	58

8. What other kinds of work have you thought you might want to do? Write the names of some of these jobs on the lines below and mark the circle by those you still think might be O.K.

1st choice				
Nonscience	588	17	48	57
Science	135	42	58	61
2nd choice				
Nonscience	567	19	49	57
Science	108	39	57	62
3rd choice				
Nonscience	441	19	49	58
Science	89	43	58	58
4th choice				
Nonscience	305	22	49	57
Science	57	44	53	58

8A. (This question is for girls only.) Mark the circle for the choice that best describes you:

4 25 50 43 I am planning to be a housewife as a full-time permanent career.

21 5 46 66 I am planning to work until I get married and then I will be a housewife.

108 12 49 57 I am planning to work until I get married and will work after I get married only if my family needs extra money.

278 21 49 57 I am planning for a full-time career (other than housewife) whether or not I get married.

13 0 45 -- I have not thought much about planning for a career.

183

9. Mark the boxes next to those jobs you <u>would not take</u>. When you mark a box, write in your reason for saying you would not take the job.

(Some reasons you might have are that the job is too boring, is for women only or for men only, doesn't pay well enough, requires lying, cheating, or other immoral actions, doesn't allow enough privacy or independence, requires long and expensive schooling, doesn't have steady work, has long hours, is too dirty or dangerous.)

	WOULD NOT TAKE	WHY
a. Airplane Mechanic	☐	
b. Artist (painter, sculptor, etc.)	☐	
c. Race Car Driver	☐	
d. Auto Salesman	☐	
e. Burglar (crook, thief, etc.)	☐	
f. Business Tycoon (a "big wheel" in business)	☐	
g. Carpenter (housebuilder, woodworker, etc.)	☐	
h. Computer Programmer	☐	
i. Doctor	☐	
j. Electrical Engineer	☐	
k. Farmer	☐	
l. Auto Mechanic	☐	
m. Homemaking, [illegible]	☐	
n. High School Teacher	☐	
o. Lawyer	☐	
p. Military Officer (captain, major, etc.)	☐	
q. Musician	☐	
r. Newspaper Editor	☐	
s. Nurse	☐	
t. Politician (state senator, Congressman, etc.)	☐	
u. Professional Athlete (basketball player, tennis player, golfer, etc.)	☐	
v. Scientific Researcher	☐	
w. Social Worker (welfare worker, family counselor)	☐	
x. Truck Driver	☐	
y. Elementary School Teacher	☐	

10. Here are things some people say they like about their jobs. Which ones are important to you? (Mark the circle for your choice.)

A. Extremely important
B. Very important
C. Moderately important
D. Of only slight importance
E. Of absolutely no importance

a. Friendly people to work with
b. A job where I can see the end result of my work
c. Good income
d. Work that is challenging and gives me a chance to use my abilities
e. Work that would make it possible for me to retire after 20 years
f. A job that makes people look up to me
g. Work that I find easy
h. Work that I feel is worthwhile
i. Short hours
j. Steady work

	a.				b.				c.				d.				e.			
Extremely important	418	22	47	56	321	22	48	57	357	19	46	53	455	22	50	60	111	12	44	49
Very important	326	18	50	60	321	21	49	57	312	21	50	60	285	21	49	55	118	14	47	50
Moderately important	103	20	50	60	177	18	51	59	161	21	54	63	95	11	46	51	267	19	49	57
Of only slight importance	17	29	52	56	33	15	44	60	22	14	52	53	20	10	46	73	203	22	50	59
Of absolutely no importance	5	40	35	45	7	29	40	50	4	50	62	62	5	40	43	61	158	29	52	62

	f.				g.				h.				i.				j.			
Extremely important	115	16	43	52	77	13	41	50	497	21	40	57	43	19	43	49	439	17	46	54
Very important	189	19	49	56	129	13	44	52	271	20	47	58	91	15	46	53	250	22	51	59
Moderately important	307	24	49	58	263	17	49	55	60	13	47	60	295	22	50	58	[illegible]	24	54	61
Of only slight importance	166	19	51	59	251	26	51	59	10	0	41	--	268	20	50	59	30	30	54	60
Of absolutely no importance	86	20	52	63	185	27	55	63	14	43	53	67	158	22	49	60	8	38	56	66

11. Would you like to have a job that gave you a chance to make the world a better place for many people?

◯ Yes, very much 642 23 49 58 ◯ Not especially 114 8 48 59 ◯ Don't know 118 15 46 54

12. Do you think you will be able in your lifetime to make the world a better place for many people?

◯ Yes 222 27 49 58 ◯ No 128 11 50 56 ◯ I don't know 514 19 49 58

13. Read the following paragraph and check <u>all</u> the things you think you would do if this situation were true.

> You hear in a news report that industrial waste and sewage disposal has become a serious problem in your community. You can see for yourself that the lake and river are full of trash, have an unpleasant smell, and are overgrown with weeds and algae. No one wants to swim or fish there any more; in fact, there no longer are any fish there because of the polluted water.

If this were the situation in your home town, which of the following would you be likely to do? (Check <u>all</u> the things you think you would do)

a. Sign a petition

b. Talk to people at school or in your club or church about things the group could do

c. Try to find out more about the problem by reading or doing a school project to study it

d. Consider changing your career plans to something where you could be more helpful in solving problems of the environment

e. Nothing; I wouldn't feel it was my problem.

f. Nothing; I wouldn't feel there was anything I could do about it.

a.	Unchecked	195	17	42	52
	Checked	689	21	50	59
b.	Unchecked	205	17	47	55
	Checked	679	21	49	58
c.	Unchecked	345	17	47	55
	Checked	539	22	50	59
d.	Unchecked	711	21	50	58
	Checked	173	17	45	55
e.	Unchecked	869	20	49	58
	Checked	15	13	41	40
f.	Unchecked	837	21	49	58
	Checked	47	6	43	51

g. Do you think you really could help solve this problem?

Yes 614 21 50 58 No 182 16 47 56 Don't know 14 7 49 48 Maybe 10 50 41 54

14. In your career would you rather be known as: (Mark one)

○ A person with good, new ideas 305 24 52 60

○ A person who gets things done 519 19 47 56

15. What single thing has been <u>most helpful</u> to you in planning for a career?

____

16. What single thing do you <u>most wish</u> you had to help you in planning for a career?

____

17. What two things would you tell a friend about planning a career?

(a) ____

____

(b) ____

18. Write a short paragraph in answer to this question: "What do you think of a career in <u>science</u> for yourself?" That is, why would you or would you not want to work in a science-related job? (Some science-related jobs are listed below to help you in answering.)

What do you think of a career in <u>science</u> for yourself (i.e., would you or would you not want to work in a science-related job)?

Yes	424	33	52	58
No	221	5	47	53
Don't know	29	17	53	60
Maybe	43	9	54	61

SCIENCE-RELATED JOBS

Physicist, Physical Scientist
Physical Science Lab Technician
Chemist
Metallurgist
Geologist
Engineer
Draftsman
Electronics Technician
Computer Operator, Programmer

Biologist
Biochemist
Medical Researcher
Doctor
Nurse
Pharmacist
Medical, Biological Lab Technician
Physical Therapist
Dentist
Dental Technician, Hygienist
Veterinarian
Wildlife, Conservation Specialist
Agricultural Scientist

Science Teacher
Mathematics Teacher
Mathematician
Statistician
Economist
Social Scientist
Psychologist

19. One word which best describes a person who chooses a science-related career is

____

20. If I went into a science-related career I would have to put off getting married for too long.

◯ Yes 74 19 48 57 ◯ No 351 25 51 58 ◯ Don't know 394 17 48 57

187

21. What if you were asked to work as a Student Counselor on Career Education? Your job is to help other students think about jobs they might like to have in the future. Rate the following activities on how helpful they would be to the students in thinking and finding out about jobs. (Mark the circle for your choice.)

ities | Usefulness

a. Seeing movies or filmstrips about jobs

b. Taking tests to find out about their abilities, interests, and personality

c. Talking to school counselors

d. Reading about jobs and job opportunities

e. Talking with teachers about jobs

f. Playing classroom or computer games to find out about job interests

g. Taking a class in career education

h. Group discussions in which students talk about what they want in a career

i. Touring plants and businesses to see what it is like to work in jobs

j. Listening to guest speakers describe the job they work in

k. Extracurricular activities (such as school clubs and sports) to find out about interests

l. Finding summer or after-school employment or doing volunteer work to get job experience and find out about their interests

m. Looking up government and other reports on job opportunities

n. Reading books about leaders in different fields

a.				
Very Useful	298	17	47	46
Somewhat Useful	490	23	50	57
Useless	34	18	50	61
Not Sure	32	16	44	54
b.				
Very Useful	495	23	50	57
Somewhat Useful	299	19	49	59
Useless	34	9	42	46
Not Sure	29	14	45	59
c.				
Very Useful	310	20	49	57
Somewhat Useful	409	20	50	57
Useless	81	21	47	58
Not Sure	52	27	48	62
d.				
Very Useful	398	21	50	58
Somewhat Useful	396	21	49	57
Useless	27	15	45	65
Not Sure	26	19	57	55
e.				
Very Useful	204	14	50	56
Somewhat Useful	478	23	49	58
Useless	93	18	47	55
Not Sure	70	24	49	58
f.				
Very Useful	151	17	48	58
Somewhat Useful	347	21	50	58
Useless	239	18	48	55
Not Sure	110	28	51	58
g.				
Very Useful	369	18	48	57
Somewhat Useful	358	22	49	57
Useless	53	21	52	59
Not Sure	68	26	52	60

h.				
Very Useful	296	19	48	56
Somewhat Useful	379	21	49	59
Useless	106	22	50	55
Not Sure	66	20	51	61
i.				
Very Useful	554	21	50	59
Somewhat Useful	250	19	49	56
Useless	26	23	46	45
Not Sure	22	9	44	73
j.				
Very Useful	448	22	50	59
Somewhat Useful	337	20	49	57
Useless	40	13	44	43
Not Sure	23	9	43	47
k.				
Very Useful	271	21	50	58
Somewhat Useful	283	22	49	58
Useless	99	18	48	56
Not Sure	90	12	46	50
l.				
Very Useful	615	22	50	58
Somewhat Useful	192	17	47	56
Useless	21	0	43	—
Not Sure	21	24	46	60
m.				
Very Useful	204	19	49	58
Somewhat Useful	457	23	50	58
Useless	90	16	47	53
Not Sure	90	19	49	58
n.				
Very Useful	138	20	44	55
Somewhat Useful	387	23	50	58
Useless	198	16	50	59
Not Sure	124	20	49	57

22. As in the last question, what if you were a Student Counselor on Career Education? Rate how important you think it is for the students finishing your program to know the following things. (Mark the circle for your choice.)

Things to Know | Importance for Your Career Education Program

a. How to set goals for themselves, to plan their own future

b. Where to get information on careers

c. What jobs are available in your local community

d. Where they can get training for the job they want

e. How to check up on working conditions, salaries, and employer or union practices before deciding on a job

f. What abilities, interests, and personality types match up with what jobs

g. How high school courses relate to future jobs

h. Jobs that are predicted to be opening up in the near future

i. How they can prepare themselves for changing job opportunities

j. How careers can be grouped; careers they can consider that are related to one they are interested in but don't feel they are able to enter

k. What are the requirements ’ .ﬀerent jobs

	a.				b.				c.				d.			
Very Important	703	22	50	58	545	20	49	58	474	17	49	57	722	21	49	58
Somewhat Important	129	16	48	55	285	21	49	57	316	26	50	59	109	21	48	55
Not Important	7	0	43	--	9	11	42	43	34	18	49	52	5	0	57	--
Not Sure	11	0	40	--	6	17	43	44	19	11	44	60	6	0	40	--

	e.				f.				g.				h.			
Very Important	553	23	50	57	507	21	49	58	516	21	49	58	428	21	50	58
Somewhat Important	258	17	49	58	282	21	49	58	281	20	50	57	327	20	48	58
Not Important	21	5	45	75	37	19	47	49	31	26	48	56	52	25	46	53
Not Sure	16	13	43	64	14	21	48	63	16	13	48	50	30	17	45	57

	i.				j.				k.			
Very Important	444	22	50	58	327	22	49	58	644	21	50	58
Somewhat Important	319	19	48	58	382	21	49	58	175	19	48	56
Not Important	37	24	46	53	54	19	47	51	9	0	49	--
Not Sure	33	18	48	51	72	15	49	58	12	8	44	62

FINDING OUT ABOUT CAREERS

23. You may have spent some school time thinking and finding out about jobs. Mark the circles below to show how much time you have spent doing different things.

A. More than 20 hours
B. 6–20 hours
C. 1–5 hours
D. 1 hour or less
E. No time at all

a. Talking with teachers about jobs you are interested in
b. Taking tests to find out what you are able to do
c. Talking about what jobs you would like
d. Listening to guest speakers from different jobs
e. Reading about different jobs
f. Going out and seeing what people do in jobs you are interested in
g. Seeing movies about different jobs
h. Talking to counselors about jobs you are interested in
i. Playing games that have to do with different jobs
j. Playing computer games that have to do with different jobs
k. Reading about leaders in different fields
l. Looking up government and private reports on job opportunities

	a.				g.				
More than 20 hours	55	22	48	58		39	13	47	60
6–20 hours	97	20	50	54		126	23	47	59
1–5 hours	219	25	50	58		286	21	49	55
1 hour or less	292	20	49	58		232	22	49	58
No time at all	186	15	48	59		149	19	50	60
	b.				h.				
More than 20 hours	55	13	46	53		40	18	45	62
6–20 hours	199	27	52	60		111	20	47	57
1–5 hours	316	22	51	58		232	25	50	59
1 hour or less	157	17	44	55		243	21	49	55
No time at all	115	13	47	57		213	15	50	59
	c.				i.				
More than 20 hours	165	22	51	60		23	13	45	56
6–20 hours	198	23	51	59		42	12	46	51
1–5 hours	251	20	49	59		125	20	46	58
1 hour or less	177	20	46	54		179	25	49	57
No time at all	43	9	47	55		471	20	50	59
	d.				j.				
More than 20 hours	49	6	47	55		19	5	44	55
6–20 hours	135	29	48	61		29	14	48	62
1–5 hours	338	23	51	57		74	28	44	54
1 hour or less	186	16	47	58		145	23	48	57
No time at all	135	16	49	56		560	20	50	59
	e.				k.				
More than 20 hours	101	23	48	58		41	17	50	57
6–20 hours	177	28	50	61		78	14	48	60
1–5 hours	289	20	50	57		181	29	50	59
1 hour or less	191	15	48	53		225	22	48	57
No time at all	67	13	48	58		308	17	50	57
	f.				l.				
More than 20 hours	91	22	51	59		37	24	43	53
6–20 hours	158	24	47	58		57	19	48	60
1–5 hours	229	24	48	56		154	27	50	58
1 hour or less	158	18	50	58		196	22	50	61
No time at all	200	17	50	60		390	17	49	55

24. Have you ever had a part-time job or done volunteer work? ◯ Yes ◯ No
(If you answered No, go to question 25.)

- Write in the name of part-time or volunteer jobs you have had:

______________________ ◯ ☐

______________________ ◯ ☐

______________________ ◯ ☐

______________________ ◯ ☐

- Mark the circle by those jobs that have given you information about a career or careers in which you are/were interested.
- Mark the square by those jobs that have interested you in a career.

25. What do you think is the best way to find out about a job?

____

____

Mark the circles for each question below (questions 26-31). If you mark Yes, answer the questions in the box that follows.

26. Have you ever looked for books, magazines, or newspapers on different careers? (If No, go to question 27.)

Yes	5o2	22	49	58
No	280	18	49	58

- How hard was it to find the information?

◯ Impossible ◯ Very hard ◯ Average ◯ Fair: ◯ Very easy

- Where did you find the information? (Mark as many as

◯ School library ◯ Public library ◯ Home ◯ Counseling office ◯ Career center

◯ Other ______________________________
specify

- Was the information that you found useful?

◯ Not at all ◯ Of little use ◯ Average ◯ Fairly useful ◯ Very useful

- Name one book, magazine, or newspaper (if you can remember one) that you have looked for:

Technical	36	39	50	58
Nontechnical	178	19	47	55

How hard was it to find the information?

Impossible	6	17	33	49
Very hard	61	16	49	53
Average	235	15	48	59
Fairly easy	202	30	51	58
Very easy	65	22	43	58

Was the information that you found useful?

Not at all	12	8	44	60
Of little use	64	19	46	59
Average	130	19	49	59
Fairly useful	236	23	51	60
Very useful	125	22	46	52

Where did you find the information?

School library				
Unchecked	318	21	48	56
Checked	205	26	49	60
Public library				
Unchecked	29C	21	47	55
Checked	225	26	51	60
Home				
Unchecked	344	20	49	57
Checked	179	28	49	59
Counseling office				
Unchecked	381	22	49	57
Checked	142	26	48	58
Career Center				
Unchecked	295	19	49	58
Checked	228	28	49	57
Other				
Unchecked	417	23	49	57
Checked	106	23	46	59

27. Have you ever gotten interested in a career just from reading a book, a magazine, or a newspaper? (If No, go to question 28.)

Yes 376
No 431

• What are some of these careers?

1st choice				
Nonscience	262	15	49	55
Science	61	57	55	60
2nd choice				
Nonscience	168	16	49	54
Science	48	54	55	60

3rd choice	
Nonscience	9
Science	1
4th choice	
Nonscience	1
Science	

• Name one book, magazine, or newspaper (if you can remember one) that got

Technical	28	36	61	63
Nontechnical	160	24	49	56

192

28. Have you ever talked with people at school about different careers? (If No, go to question 29.)

Yes	675	23	50	58
No	160	13	47	55

• Who are some of the people you talked with? (Mark as many as apply)

◯ Teacher ◯ Counselor ◯ Coach ◯ Friend ◯ Career center worker

◯ Other ______________________________
specify

• Who have you talked with the <u>most</u>?

◯ Teacher ◯ Counselor ◯ Coach ◯ Friend ◯ Career center worker

◯ Other ______________________________
specify

• For the person you have talked with most, how hard has it been to talk to him/her?

◯ Almost impossible ◯ Very hard ◯ Average ◯ Fairly easy ◯ Very easy

• How useful was the information you got from this person?

◯ Useless ◯ Of little use ◯ Average ◯ Fairly useful ◯ Very useful

Who are some of the people you talked with?					Who have you talked with the <u>most</u>?			
Teacher					73	22	49	60
Unchecked	322	20	48	59				
Checked	314	[illegible]	51	57				
Counselor					96	26	49	58
Unchecked	290	20	48	56				
Checked	346	28	51	59				
Coach					16	11	46	48
Unchecked	572	26	50	58				
Checked	64	13	49	55				
Friend					309	25	[illegible]	60
Unchecked	146	24	46	57				
Checked	490	24	51	58				
Career center worker					31	26	48	56
Unchecked	506	24	50	58				
Checked	130	25	47	55				
Other					33	27	46	56
Unchecked	564	25	50	58				
Checked	72	22	49	54				

For the person you have talked with most, how hard has it been to talk to him/her?

Almost impossible	5	0	42	--
Very hard	14	[illegible]	44	40
Average	98	22	[illegible]	57
Fairly easy	176	27	[illegible]	59
Very easy	375	23	[illegible]	53

How useful was the information you got from this person?

Useless	19	26	54	54
Of little use	79	28	52	59
Average	184	21	50	56
Fairly useful	215	25	51	59
Very useful	160	21	46	55

29. Have you ever gotten interested in a career just from talking with people at school? (If No, go to question 30.)

Yes	317	21	49	55
No	518	21	49	59

- What are some of these careers?

____________________ ____________________

____________________ ____________________

- Who got you interested? (Mark as many as apply)

◯ Teacher ◯ Counselor ◯ Coach ◯ Friend ◯ Career center worker

◯ Other ____________________ specify

- Who got you most interested in a career?

◯ Teacher ◯ Counselor ◯ Coach ◯ Friend ◯ Career center worker

◯ Other ____________________ specify

What are some of these careers?

1st choice				
Nonscience	213	15	49	56
Science	38	61	53	55
2nd choice				
Nonscience	134	21	48	54
Science	22	27	58	57
3rd choice				
Nonscience	74	12	47	52
Science	13	23	54	53
4th choice				
Nonscience	28	4	47	39
Science	2	50	56	40

Who got you interested?					Who got you most interested in a career?			
Teacher					67	18	54	58
Unchecked	169	18	47	53				
Checked	117	26	52	57				
Counselor					24	17	45	54
Unchecked	239	21	49	56				
Checked	47	26	47	51				
Coach					8	10	48	38
Unchecked	272	22	49	55				
Checked	14	7	51	50				
Friend					96	21	50	58
Unchecked	120	17	46	53				
Checked	166	25	51	56				
Career center worker					17	12	42	47
Unchecked	254	21	49	56				
Checked	32	22	44	47				
Other					51	24	47	51
Unchecked	236	22	49	56				
Checked	50	20	46	49				

30. Have you ever talked with people outside of school about different careers? (If No, go to question 31.)

Yes	619	23	50	58
No	152	15	45	56

• Who are some of the people you talked with? (Mark as many as apply)

◯ Father ◯ Mother ◯ Other family ◯ Friend

◯ Person with a job in ____________________
give name of job

◯ Others ____________________
who were they

• Who have you talked with the <u>most</u>?

◯ Father ◯ Mother ◯ Other family ◯ Friend

◯ Person with a job in ____________________
give name of job

◯ Others ____________________
who were they

• For the person you have talked with most, how hard has it been to talk to him/her?

◯ Almost impossible ◯ Very hard ◯ Average ◯ Fairly easy ◯ Very easy

• How useful was the information you got from this person?

◯ Useless ◯ Of little use ◯ Average ◯ Fairly useful ◯ Very useful

Who are some of the people you talked with?					Who have you talked with the most?			
Father					121	31	55	61
Unchecked	253	16	47	53				
Checked	378	28	52	60				
Mother					157	25	50	61
Unchecked	212	17	48	55				
Checked	419	26	51	59				
Other family					42	14	49	56
Unchecked	376	23	49	58				
Checked	255	23	51	58				
Friend					118	19	49	57
Unchecked	220	22	49	57				
Checked	411	24	50	59				
Person with job in					40	20	53	52
Nonscience	258	10	50	55				
Science	69	78	52	61				
Others					9	0	52	--
Unchecked	535	23	50	59				
Checked	96	24	49	56				

For the person you have talked with most, how hard has it been to talk to him/her?				
Almost impossible	2	0	42	--
Very hard	26	15	48	62
Average	91	21	48	53
Fairly easy	175	25	51	59
Very easy	361	22	51	59

How useful was the information you got from this person?				
Useless	9	0	51	--
Of little use	44	36	47	62
Average	134	21	48	55
Fairly useful	241	24	52	60
Very useful	207	20	50	58

31. Have you ever gotten interested in a career just from talking with people outside of school? (If No, go to question 32.)

Yes	358	20	49	58
No	443	21	50	58

- What are some of these careers?

____________________ ____________________

____________________ ____________________

- Who got you interested? (Mark as many as apply)

○ Father ○ Mother ○ Other family ○ Friend

○ Person with a job in ____________________
give name of job

○ Others ____________________
who were they

- Who have you talked with the most?

○ Father ○ Mother ○ Other family ○ Friend

○ Person with a job in ____________________
give name of job

○ Others ____________________
who were they

1st choice				
Nonscience	250	14	49	55
Science	48	67	57	61
2nd choice				
Nonscience	140	11	49	57
Science	37	62	57	58
3rd choice				
Nonscience	85	11	47	53
Science	14	79	49	58
4th choice				
Nonscience	32	13	46	59
Science	7	29	44	55

Who got you interested?					Who have you talked with most?			
Father					46	26	54	64
Unchecked	[illegible]	18	48	57				
Checked	87	29	52	61				
Mother					38	21	47	62
Unchecked	253	19	49	58				
Checked	86	26	50	59				
Other family					26	27	50	[illegible]
Unchecked	252	19	49	59				
Checked	87	28	49	58				
Friend					81	16	48	57
Unchecked	173	23	50	60				
Checked	166	19	48	56				
Person with job in					29	28	56	62
Nonscience	120	17	50	55				
Science	29	72	56	61				
Others					9	22	52	68
Unchecked	295	21	49	58				
Checked	44	23	47	60				

Mark the circles for each question below (questions 32 through 34). If you mark Yes, answer the questions in the box that follows. If you mark No, skip the box and go on to the next question.

32. Have you learned about people who work in SCIENCE jobs from people? (If No, skip to question 33.)

Yes	291	34	53	60
No	517	14	48	55

- Which people did you learn from? (Mark as many as apply)

◯ Teachers ◯ Counselors ◯ Parents ◯ Friends ◯ People in science jobs

◯ Others ________________ who were they

- Who more than the others?

◯ Teacher ◯ Counselor ◯ Parent ◯ Friend ◯ Person in science job

◯ Other ________________ who

- Was it hard to talk to this person?

Yes	37	24	48	52
No	245	36	53	61

- Was the information this person gave you helpful?

Yes	240	35	53	60
No	39	28	48	56

Which people did you learn from?				
Teachers				
Unchecked	157	36	50	58
Checked	129	34	55	62
Counselors				
Unchecked	239	33	52	59
Checked	47	45	55	63
Parents				
Unchecked	183	30	51	58
Checked	103	45	55	62
Friends				
Unchecked	192	32	53	58
Checked	94	40	52	64
People in science jobs				
Unchecked	129	26	50	56
Checked	157	42	55	62
Others				
Unchecked	252	34	53	59
Checked	34	41	49	62

Who more than the others?				
Teacher	65	17	53	56
Counselor	16	31	47	59
Parent	41	37	57	63
Friend	29	37	46	56
Person in science job	84	45	56	60
Other	10	70	53	63

33. Have you learned about people who work in SCIENCE jobs from books, magazines, TV, movies, etc.? (If No, skip to question 34.)

Yes	368	29	53	58
No	420	14	47	57

- Which of these sources did you learn from? (Mark as many as apply)

◯ Books ◯ Magazines ◯ TV ◯ Movies ◯ Newspapers
◯ Other ____________________ specify

- Which source more than the others?

◯ Books ◯ Magazines ◯ TV ◯ Movies ◯ Newspapers
◯ Other ____________________ specify

- Was this source hard to find?

Yes	33	45	46	55
No	341	27	53	59

- Was the information it gave helpful?

Yes	293	30	52	58
No	72	24	51	58

Which of these sources did you learn from?					Which source more than others?			
Books					82	46	54	60
Unchecked	161	23	50	55				
Checked	198	35	55	60				
Magazines					76	28	52	60
Unchecked	136	25	48	54				
Checked	223	32	55	60				
TV					112	19	53	59
Unchecked	91	30	50	53				
Checked	268	29	53	60				
Movies					22	32	46	56
Unchecked	221	31	52	56				
Checked	138	27	53	62				
Newspapers					15	27	56	57
Unchecked	225	27	50	56				
Checked	134	34	56	62				
Other					9	33	47	43
Unchecked	343	29	52	59				
Checked	16	38	54	48				

34. Have you learned about people who work in SCIENCE jobs <u>from things you have done</u>? (If No, skip to question 35.)

Yes	222	32	53	58
No	558	17	48	58

- Which things did you learn from? (Mark as many as apply)

◯ Part-time job ◯ Summer job ◯ Volunteer work ◯ School tests ◯ Sports
◯ Other ______________________ specify

- Which thing more than the others?

◯ Part-time job ◯ Summer job ◯ Volunteer work ◯ School tests ◯ Sports
◯ Other ______________________ specify

- Was it hard to get the opportunity?

Yes	176	31	49	58
No	53	30	53	59

- Was the information you got helpful?

Yes	189	33	53	59
No	33	15	49	56

Which things did you learn from?					Which thing more than the others?			
Part-time job					24	25	53	63
Unchecked	180	32	52	57				
Checked	39	36	52	61				
Summer job					22	36	45	50
Unchecked	183	32	53	59				
Checked	36	36	50	56				
Volunteer work					42	36	50	56
Unchecked	163	31	53	59				
Checked	56	36	50	56				
School tests					67	34	53	57
Unchecked	116	34	51	58				
Checked	103	31	53	59				
Sports					10	10	55	42
Unchecked	191	33	52	58				
Checked	28	29	52	60				
Other					47	34	57	66
Unchecked	163	31	51	56				
Checked	56	38	57	64				

STUDENT INFORMATION: EDUCATION

35. Do you think you will quit high school before you graduate?

◯ Yes 10 10 45 58　　◯ No 796 21 50 58　　◯ I don't know 40 10 40 50

36. Give a short answer for each question that follows:

a. Why do you (or do you not) want to graduate from high school?

____

b. Can you get a good job after you graduate from high school?

Yes 374 19 47 54　No 186 31 55 61　Don't know 112 14 49 60　Maybe 137 17 48 57

c. What courses in high school do you feel will be most important to you in the future?

____

d. Would you like to have a part-time job while you are in high school?

Yes 693 20 49 57　No 76 30 54 62　Don't know 6 17 52 60　Maybe 12 8 58 40

200

37. Do you think you will go into the armed forces (such as the Army, Navy, Air Force, Reserves) after high school or college?

61 7 43 51 Yes, after high school

28 18 46 55 Yes, after college

5 40 56 50 Yes, I plan to take ROTC in high school

19 21 51 54 Yes, I plan to take ROTC in college

464 21 50 59 No, I do not plan to serve in the armed forces

243 23 49 56 I don't know

38. Do you plan to take courses after graduating from high school to prepare you for a science-related career?

244 50 56 60 Yes, at college I may major in a science field

42 19 43 50 Yes, I plan to attend a vocational school to learn a science trade (such as computer programming)

335 5 48 53 No

213 11 49 52 I don't know

39. Which type of college do you expect to attend?

337 30 54 60 A four-year college

108 6 45 53 A community (junior) college

190 27 50 57 A community (junior) college for two years and then four-year college

61 0 44 -- I don't plan to go to any college

128 12 43 49 I don't know

40. What is the highest educational degree you expect to receive?

125 6 41 47 High school diploma

71 0 45 -- A.A. (Associate in Arts; junior college degree)

91 8 52 59 A.B. (Bachelor of Arts)

92 15 54 60 M.A. (Master of Arts)

80 43 55 58 M.S. (Master of Science)

44 48 56 61 Ph.D. (Doctor of Philosophy)

76 76 47 59 M.D. (Doctor of Medicine)

24 4 51 43 Ed.D. (Doctorate in Education)

57 9 53 51 J.D. (Doctorate in Law)

78 21 49 57 Other ______________________ specify

41. Starting with courses taken in the ninth grade, how many semesters (half-years) of each of the following kinds of courses have you taken? <u>Include those which you are taking now.</u> Mark your answers as follows:

A. None
B. One or two semesters
C. Three or four semesters
D. Five semesters
E. Six semesters
F. Seven or more semesters

a. Science courses (biology, chemistry, general science, physics, etc.)

b. Foreign languages (French, German, Spanish, Latin, etc.)

c. Social studies (history, civics, government, economics, etc.)

d. English courses (grammar, composition, literature, etc.)

e. Business or commercial courses (typing, bookkeeping, shorthand, business law, commercial arithmetic, etc.)

f. Vocational, shop, or agricultural courses

g. Mathematics courses (algebra, geometry, trigonometry, etc.). Do <u>not</u> count commercial arithmetic or shop mathematics.

h. How many more science courses do you plan to take?

	a.				b.				c.				d.			
None	69	10	43	44	271	11	44	47	42	7	40	54	26	8	38	39
One or two semesters	371	15	47	54	218	20	48	57	252	21	48	56	75	16	40	52
Three or four semesters	268	25	51	57	228	28	55	61	227	26	49	57	209	18	49	56
Five semesters	25	40	57	60	18	22	52	60	66	18	48	57	82	21	49	56
Six semesters	60	30	59	66	66	36	59	62	138	21	54	61	153	25	49	59
Seven or more semesters	37	51	64	65	26	35	55	58	99	17	51	61	190	25	56	61

	e.				f.				g.				h.			
None	234	22	49	56	414	22	49	59	75	9	40	41	320	9	47	58
One or two semesters	382	25	52	61	214	22	51	58	137	12	42	50	234	18	49	57
Three or four semesters	130	14	46	50	98	21	47	54	327	20	50	56	133	30	53	57
Five semesters	27	11	48	47	30	1[illegible]	45	44	53	23	52	55	21	29	49	54
Six semesters	25	12	43	48	17	6	50	68	124	35	57	60	32	34	48	62
Seven or more semesters	28	7	45	54	33	18	50	55	105	29	55	65	73	51	53	59

42. This question asks about your grades in courses you have taken in the ninth grade or later. Please report only semester grades. If you have not taken any courses in a subject, skip the item. Mark only one circle for each item. Mark your answers as follows:

(1) All A's or equivalent
(2) Mostly A's or equivalent
(3) Mostly A's and B's or equivalent
(4) Mostly B's and C's or equivalent
(5) Mostly C's and D's or equivalent
(6) Mostly D's or below or equivalent

NOTE: If your school does not use letter grades, please use the following equivalents:

Equivalents

For a grade of A:	Excellent;	90-100
For a grade of B:	Good;	80-89
For a grade of C:	Average;	70-79
For a grade of D:	Fair;	60-69
For a grade below D:	Failing;	59 or lower

a. My grades in mathematics have been:

b. My grades in science courses have been:

c. My grades in foreign languages have been:

d. My grades in history and social studies courses have been:

e. My grades in English courses have been:

f. My grades in vocational courses have been:

g. My grades in business or commercial courses have been:

h. My grades in all courses starting with the ninth grade have been:

	a.				b.				c.				d.			
All A's	103	36	56	61	112	38	58	63	119	37	56	63	152	36	59	62
Mostly A's	120	26	52	60	104	31	51	62	92	29	53	60	145	26	52	60
Mostly A's and B's	218	24	50	60	223	21	50	56	195	22	52	57	216	19	49	54
Mostly B's and C's	262	16	47	51	252	12	48	52	134	21	48	56	212	11	46	54
Mostly C's and D's	100	12	45	52	89	16	43	52	50	6	45	50	68	10	41	46
Mostly D's or below	12	0	41	—	12	8	38	69	75	12	42	54	7	29	37	69

	e.				f.				g.				h.			
All A's	132	34	58	63	96	24	54	63	116	34	55	63	39	41	57	64
Mostly A's	154	25	52	56	110	26	52	57	100	21	50	56	145	33	53	60
Mostly A's and B's	246	18	49	58	136	12	48	57	148	17	49	57	325	22	51	58
Mostly B's and C's	205	15	46	54	104	13	43	48	127	11	46	48	225	11	46	50
Mostly C's and D's	59	17	42	49	20	5	40	40	39	10	43	51	39	18	40	51
Mostly D's or below	1	0	39	—	9	44	41	58	9	22	38	51	2	0	41	—

43. How many clubs or organizations (other than athletic) have you belonged to in the last three years?

None	1	2	3	4	5
168 17 45 54	140 20 47 54	147 20 48 55	114 22 50 57	101 25 53 59	51 12 55 63
6	**7**	**8**	**9**	**10**	**11 or more**
28 36 48 63	18 17 59 69	13 15 59 75	5 20 65 58	8 75 62 72	18 39 55 61

44. How old were you when you first went out on a date?

122 26 50 60	89 10 47 54	295 21 46 56	194 21 50 57	79 27 53 62	12 25 49 59
I have never had a date.	12 or younger	13 or 14	15	16	17 or older

45. On the average, how many dates do you have in a week?

212 26 52 60	259 22 51 56	150 17 46 57	83 14 46 49	29 21 45 61	20 10 42 61
I never have dates.	About 1	About 2	About 3	About 4 or 5	About 6 or 7

46. Which best describes how you do your school homework?

- ◯ I get it done early--way before it is due. 151 17 45 54
- ◯ I get it done but sometimes wait until the last minute. 580 22 51 58
- ◯ Often I do not finish on time. 86 17 46 57

47. How fast do you do each of these compared to other students at your school? (Mark the circles for your choice)

A. Faster than most students
B. Average
C. Slower than most students
D. I never noticed

a. Eating

b. Math problems

c. Walking

d. Talking

e. Reading

	a.	b.	c.	d.	e.
Faster than most students	154 19 52 59	235 34 56 61	313 25 51 60	171 20 50 58	292 27 55 62
Average	479 23 49 57	411 18 48 55	403 19 49 56	519 22 50 58	363 18 47 55
Slower than most students	88 20 49 57	144 13 45 52	56 11 47 55	64 14 45 57	128 17 46 53
I never noticed.	93 16 48 60	26 4 44 51	39 23 50 53	61 21 48 56	36 17 42 49

48. List some of the things you like to do in your spare time:

______________________ ______________________

______________________ ______________________

49. Rate yourself in relation to other students at your school on the following abilities, interests, information areas, and attitudes. Mark the line at the point you feel best describes you and mark one of the boxes to say how sure you are of your answer. The numbers mean:

1 = Very much above average
2 = Above average
3 = Average
4 = Below average
5 = Very much below average

		Very Sure	Fairly Sure	Not Sure
a. Understanding quickly what I read	1 2 3 4 5	☐	☐	☐
b. Solving problems in mathematics	1 2 3 4 5	☐	☐	☐
c. Creativity	1 2 3 4 5	☐	☐	☐
d. Interest in science	1 2 3 4 5	☐	☐	☐
e. Interest in working with tools	1 2 3 4 5	☐	☐	☐
f. Interest in office work	1 2 3 4 5	☐	☐	☐
g. Interest in helping people	1 2 3 4 5	☐	☐	☐
h. Vocabulary	1 2 3 4 5	☐	☐	☐
i. Knowledge about science	1 2 3 4 5	☐	☐	☐
j. Responsibility	1 2 3 4 5	☐	☐	☐
k. Independence (ability to work on my own)	1 2 3 4 5	☐	☐	☐
l. Desire for a job that provides prestige	1 2 3 4 5	☐	☐	☐
m. Desire for a job that provides good income	1 2 3 4 5	☐	☐	☐
n. Desire for a challenging job	1 2 3 4 5	☐	☐	☐
o. Desire to work with friendly, likeable people	1 2 3 4 5	☐	☐	☐

Mark Yes or No for each question below (questions 50 through 52). If you mark Yes, answer the questions in the box that follows. If you mark No, go on to the next question.

50. Have you learned about the kind of person you are from people? (If No, skip to question 51.)

Yes	620	20	50	57
No	192	24	46	60

- Which people did you learn from? (Mark as many as apply)

◯ Teachers ◯ Counselors ◯ Parents ◯ Friends

◯ Others ______________________ who were they

- Who more than the others?

◯ Teacher ◯ Counselor ◯ Parent ◯ Friend

◯ Other ______________________ who

- Was it hard to talk to this person?

Yes	87	18	49	53
No	512	21	51	58

- Was the information this person gave you helpful?

Yes	548	21	51	57
No	47	26	43	55

Which people did you learn from?				
Teachers				
Unchecked	315	17	48	55
Checked	271	26	53	58
Counselors				
Unchecked	429	20	50	56
Checked	137	24	52	60
Parents				
Unchecked	177	15	47	52
Checked	409	24	52	58
Friends				
Unchecked	58	14	40	52
Checked	528	22	52	57
Others				
Unchecked	502	22	50	57
Checked	84	19	51	57

Who more than the others?				
Teacher	25	20	45	48
Counselor	14	21	42	58
Parent	118	19	52	56
Friend	33[illegible]	21	52	58
Other	29	31	49	54

51. Have you learned about the kind of person you are <u>from books, magazines, TV, movies, etc.</u>? (If No, skip to question 52.)

Yes	240	19	52	59
No	550	22	48	58

- Which of these sources did you learn from? (Mark as many as apply)

◯ Books ◯ Magazines ◯ TV ◯ Movies ◯ Newspapers
◯ Other ______________ specify

- Which source more than the others?

◯ Books ◯ Magazines ◯ TV ◯ Movies ◯ Newspapers
◯ Other ______________ specify

- Was this source hard to find?

Yes	31	16	44	50
No	206	20	53	59

- Was the information it gave helpful?

Yes	226	20	52	58
No	12	25	49	70

	Which of these sources did you learn from?				Which source more than others?			
Books					98	28	57	61
Unchecked	74	16	45	54				
Checked	154	23	55	60				
Magazines					51	16	50	63
Unchecked	101	23	51	53				
Checked	127	19	52	64				
TV					35	9	49	51
Unchecked	115	20	50	58				
Checked	113	21	53	59				
Movies					18	22	45	51
Unchecked	133	21	50	57				
Checked	95	20	54	60				
Newspapers					6	17	63	63
Unchecked	168	21	50	57				
Checked	60	20	55	64				
Other						44	44	51
Unchecked	212	20	52	59				
Checked	16	25	44	51				

52. Have you learned about the kind of person you are from things you have done? (If No, skip to question 53.)

Yes	647	22	50	58
No	147	18	46	59

- Which things did you learn from? (Mark as many as apply)

◯ Part-time job ◯ Summer job ◯ Volunteer work ◯ Sports ◯ Clubs ◯ Hobbies

◯ Other ______________________ specify

- Which thing more than the others?

◯ Part-time job ◯ Summer job ◯ Volunteer work ◯ Sports ◯ Clubs ◯ Hobbies

◯ Other ______________________ specify

- Was it hard to get the opportunity?

Yes	97	21	49	56
No	522	23	51	56

- Was the information you got helpful?

Yes	568	23	51	58
No	42	24	48	52

Which things did you learn from?					Which thing more than the others ?			
Part-time job					59	24	50	57
Unchecked	390	22	49	57				
Checked	230	24	53	59				
Summer job					52	12	47	53
Unchecked	413	25	50	58				
Checked	207	19	50	57				
Volunteer work					52	15	48	58
Unchecked	436	23	49	58				
Checked	184	22	52	57				
Sports					125	19	53	58
Unchecked	270	20	47	57				
Checked	350	25	53	58				
Clubs					43	28	50	58
Unchecked	354	22	48	55				
Checked	266	24	53	60				
Hobbies					178	26	51	59
Unchecked	182	18	47	55				
Checked	438	25	52	58				
Other					43	38	54	63
Unchecked	556	21	50	57				
Checked	64	36	51	60				

SCHOOL AND COMMUNITY INFORMATION

5 How important are each of these things to most students at your school? (Mark the circles for your choice)

A. Extremely important
B. Very important
C. Moderately important
D. Of only slight importance
E. Of absolutely no importance

a. Dating

b. Getting good grades

c. Having a nice car

d. Running for school offices (such as student body president)

e. Getting scholarships

f. Playing on or rooting for a school team

g. School club activities

h. After-school athletics (just for fun)

i. After-school or weekend jobs

	a.				b.				c.				d.				e.			
Extremely important	215	18	48	56	174	17	45	51	176	19	45	55	43	19	45	55	165	19	46	53
Very important	289	22	51	59	292	22	49	58	250	20	50	59	116	21	47	59	251	22	50	59
Moderately important	237	21	50	59	306	22	52	60	251	23	51	58	295	20	51	58	277	21	51	59
Of only slight importance	48	23	45	53	38	26	50	54	99	21	52	59	270	22	51	58	86	24	50	61
Of absolutely no importance	19	21	41	60	0	--	--	--	23	17	48	62	85	24	44	57	18	11	38	41

	f.				g.				h.				i.			
Extremely important	149	18	49	57	53	15	44	56	107	12	45	50	162	13	44	52
Very important	249	22	50	60	170	17	51	56	221	20	50	56	316	20	50	57
Moderately important	282	22	49	56	374	22	49	58	309	22	51	58	259	27	51	59
Of only slight importance	87	20	49	58	170	24	51	59	134	26	49	63	57	19	52	62
Of absolutely no importance	41	22	46	61	38	29	42	58	36	17	48	54	10	30	47	64

209

54. Following is a list of science-related jobs. For each job, mark the circle if such a job is available in or near your community.

Job	Yes	No	Don't know
Physicist	0	0	0
Physical Science Lab Technician	0	0	0
Geologist	0	0	0
Metallurgist	0	0	0
Chemist	0	0	0
Engineer	0	0	0
Draftsman	0	0	0
Electronics Technician	0	0	0
Computer Operator, Programmer	0	0	0
Molecular Biologist	0	0	0
Medical Researcher	0	0	0
Doctor	0	0	0
Nurse	0	0	0
Pharmacist	0	0	0
Physical Therapist	0	0	0
Dentist	0	0	0
Dental Technician, Hygienist	0	0	0
Veterinarian	0	0	0
Agricultural Scientist	0	0	0
Wildlife, Conservation Specialist	0	0	0
Science Teacher	0	0	0
Mathematics Teacher	0	0	0
Mathematician	0	0	0
Statistician	0	0	0
Economist	0	0	0
Social Scientist	0	0	0
Psychologist	0	0	0

55. The list of science-related jobs is printed below. <u>Mark the circle which best describes whether there are opportunities for training in these jobs in your community</u>.

Job	Yes	No	Don't know
Physicist	0	0	0
Physical Science Lab Technician	0	0	0
Geologist	0	0	0
Metallurgist	0	0	0
Chemist	0	0	0
Engineer	0	0	0
Draftsman	0	0	0
Electronics Technician	0	0	0
Computer Operator, Programmer	0	0	0
Molecular Biologist	0	0	0
Medical Researcher	0	0	0
Doctor	0	0	0
Nurse	0	0	0
Pharmacist	0	0	0
Physical Therapist	0	0	0
Dentist	0	0	0
Dental Technician, Hygienist	0	0	0
Veterinarian	0	0	0
Agricultural Scientist	0	0	0
Wildlife, Conservation Specialist	0	0	0
Science Teacher	0	0	0
Mathematics Teacher	0	0	0
Mathematician	0	0	0
Statistician	0	0	0
Economist	0	0	0
Social Scientist	0	0	0
Psychologist	0	0	0

CAREER INFORMATION

56. Mark the circles which describe how much money you think workers in the following jobs make on the average when they are 30 and the necessary education a person must have to work in each job.

a. Sales Clerk
b. Chemist
c. Business Manager
d. Computer Operator
e. Long Distance Truck Driver
f. Job you expect to have at 30

Average Yearly Income

a.				
Less than $7,000	250	22	48	56
$7,000-$9,999	331	25	51	59
$10,000-$14,999	141	18	51	60
$15,000-$24,999	29	10	42	45
More than $25,000	7	0	41	—
b.				
Less than $7,000	6	0	39	—
$7,000-$9,999	63	22	44	54
$10,000-$14,999	267	21	48	58
$15,000-$24,999	338	22	52	59
More than $25,000	80	24	50	56
c.				
Less than $7,000	15	13	40	43
$7,000-$9,999	116	22	44	52
$10,000-$14,999	303	21	49	58
$15,000-$24,999	271	25	53	60
More than $25,000	49	16	51	62
d.				
Less than $7,000	26	12	41	49
$7,000-$9,999	157	24	47	58
$10,000-$14,999	299	24	51	59
$15,000-$24,999	222	22	51	58
More than $25,000	46	11	49	52
e.				
Less than $7,000	80	21	48	56
$7,000-$9,999	185	25	50	59
$10,000-$14,999	285	21	51	58
$15,000-$24,999	163	23	49	58
More than $25,000	45	20	47	53
f.				
Less than $7,000	33	6	43	54
$7,000-$9,999	75	12	45	48
$10,000-$14,999	201	11	49	58
$15,000-$24,999	286	27	51	58
More than $25,000	142	38	52	59

Necessary Education

a.				
Grade School	42	38	53	63
High School	491	27	52	58
2-Year College	169	22	47	56
4-Year College	38	16	42	49
Graduate School	18	5	40	38
b.				
Grade School	5	0	40	—
High School	5	0	38	—
2-Year College	41	10	44	47
4-Year College	357	22	49	57
Graduate School	343	25	52	59
c.				
Grade School	4	0	40	—
High School	76	25	47	55
2-Year College	284	24	49	57
4-Year College	343	22	52	59
Graduate School	43	14	46	60
d.				
Grade School	4	0	36	—
High School	64	25	47	61
2-Year College	330	26	51	58
4-Year College	255	20	50	58
Graduate School	91	19	49	53
e.				
Grade School	125	32	54	63
High School	483	21	51	58
2-Year College	87	21	46	53
4-Year College	18	11	42	45
Graduate School	39	18	43	43
f.				
Grade School	8	25	41	53
High School	79	4	44	40
2-Year College	136	7	45	47
4-Year College	293	20	53	55
Graduate School	219	43	54	51

57. Mark the circle or circles for those jobs you think fit the descriptions listed.

	Sales Clerk	Chemist	Business Manager	Computer Operator	Long Distance Truck Driver	The job you expect to have at 30
a. Jobs in which many of the workers are women	○	○	○	○	○	○
b. Jobs for which you need to know advanced mathematics	○	○	○	○	○	○
c. Fields in which many new jobs are expected in the future	○	○	○	○	○	○
d. Jobs which usually require night work	○	○	○	○	○	○
e. Jobs for which you usually join a union	○	○	○	○	○	○
f. Workers in these jobs may help to solve important problems	○	○	○	○	○	○
g. Workers in these jobs have more influence on society in general than do workers in other jobs	○	○	○	○	○	○
h. In the past, workers in these jobs were likely to have well-to-do parents	○	○	○	○	○	○

58. Women can do the same kind of work as men:

- ◯ Always — 56 25 49 59
- ◯ Almost always — 583 23 51 59
- ◯ Not very often — 121 17 44 50
- ◯ Never — 14 14 41 42

For the next four questions you are to rate people in different careers on certain abilities, interests, information areas, and attitudes. Mark the line at the point you feel best describes people in the career and mark one of the boxes to say how sure you are of your answer.

1 = Very much above average
2 = Above average
3 = Average
4 = Below average
5 = Very much below average

59. Rate people in sales jobs on the following:

	Rating	Very Sure	Fairly Sure	Not Sure
a. Ability to understand quickly what they read	1 2 3 4 5	☐	☐	☐
b. Ability to do advanced mathematics	1 2 3 4 5	☐	☐	☐
c. Creativity	1 2 3 4 5	☐	☐	☐
d. Interest in science	1 2 3 4 5	☐	☐	☐
e. Interest in working with tools	1 2 3 4 5	☐	☐	☐
f. Interest in office work	1 2 3 4 5	☐	☐	☐
g. Interest in helping people	1 2 3 4 5	☐	☐	☐
h. Vocabulary	1 2 3 4 5	☐	☐	☐
i. Knowledge about science	1 2 3 4 5	☐	☐	☐
j. Responsibility	1 2 3 4 5	☐	☐	☐
k. Independence (able to work on their own)	1 2 3 4 5	☐	☐	☐
l. Desire for a job that provides prestige	1 2 3 4 5	☐	☐	☐
m. Desire for a job that provides good income	1 2 3 4 5	☐	☐	☐
n. Desire for a challenging job	1 2 3 4 5	☐	☐	☐
o. Desire to work with friendly, likeable people	1 2 3 4 5	☐	☐	☐

1 = Very much above average
2 = Above average
3 = Average
4 = Below average
5 = Very much below average

60. Rate chemists on the following:

						Very Sure	Fairly Sure	Not Sure
a. Ability to understand quickly what they read	1	2	3	4	5	☐	☐	☐
b. Ability to do advanced mathematics	1	2	3	4	5	☐	☐	☐
c. Creativity	1	2	3	4	5	☐	☐	☐
d. Interest in science	1	2	3	4	5	☐	☐	☐
e. Interest in working with tools	1	2	3	4	5	☐	☐	☐
f. Interest in office work	1	2	3	4	5	☐	☐	☐
g. Interest in helping people	1	2	3	4	5	☐	☐	☐
h. Vocabulary	1	2	3	4	5	☐	☐	☐
i. Knowledge about science	1	2	3	4	5	☐	☐	☐
j. Responsibility	1	2	3	4	5	☐	☐	☐
k. Independence (able to work on their own)	1	2	3	4	5	☐	☐	☐
l. Desire for a job that provides prestige	1	2	3	4	5	☐	☐	☐
m. Desire for a job that provides good income	1	2	3	4	5	☐	☐	☐
n. Desire for a challenging job	1	2	3	4	5	☐	☐	☐
o. Desire to work with friendly, likeable people	1	2	3	4	5	☐	☐	☐

1 = Very much above average
2 = Above average
3 = Average
4 = Below average
5 = Very much below average

61. Rate computer operators on the following:

	1	2	3	4	5	Very Sure	Fairly Sure	Not Sure
a. Ability to understand quickly what they read	1	2	3	4	5	☐	☐	☐
b. Ability to do advanced mathematics	1	2	3	4	5	☐	☐	☐
c. Creativity	1	2	3	4	5	☐	☐	☐
d. Interest in science	1	2	3	4	5	☐	☐	☐
e. Interest in working with tools	1	2	3	4	5	☐	☐	☐
f. Interest in office work	1	2	3	4	5	☐	☐	☐
g. Interest in helping people	1	2	3	4	5	☐	☐	☐
h. Vocabulary	1	2	3	4	5	☐	☐	☐
i. Knowledge about science	1	2	3	4	5	☐	☐	☐
j. Responsibility	1	2	3	4	5	☐	☐	☐
k. Independence (able to work on their own)	1	2	3	4	5	☐	☐	☐
l. Desire for a job that provides prestige	1	2	3	4	5	☐	☐	☐
m. Desire for a job that provides good income	1	2	3	4	5	☐	☐	☐
n. Desire for a challenging job	1	2	3	4	5	☐	☐	☐
o. Desire to work with friendly, likeable people	1	2	3	4	5	☐	☐	☐

1 = Very much above average
2 = Above average
3 = Average
4 = Below average
5 = Very much below average

62. Rate persons working in the job you expect to have at 30 on the following:

		Very Sure	Fairly Sure	Not Sure
a. Ability to understand quickly what they read	1 2 3 4 5	☐	☐	☐
b. Ability to do advanced mathematics	1 2 3 4 5	☐	☐	☐
c. Creativity	1 2 3 4 5	☐	☐	☐
d. Interest in science	1 2 3 4 5	☐	☐	☐
e. Interest in working with tools	1 2 3 4 5	☐	☐	☐
f. Interest in office work	1 2 3 4 5	☐	☐	☐
g. Interest in helping people	1 2 3 4 5	☐	☐	☐
h. Vocabulary	1 2 3 4 5	☐	☐	☐
i. Knowledge about science	1 2 3 4 5	☐	☐	☐
j. Responsibility	1 2 3 4 5	☐	☐	☐
k. Independence (able to work on their own)	1 2 3 4 5	☐	☐	☐
l. Desire for a job that provides prestige	1 2 3 4 5	☐	☐	☐
m. Desire for a job that provides good income	1 2 3 4 5	☐	☐	☐
n. Desire for a challenging job	1 2 3 4 5	☐	☐	☐
o. Desire to work with friendly, likeable people	1 2 3 4 5	☐	☐	☐

THANK YOU VERY MUCH FOR YOUR TIME ! ! !